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. NEW SPECIES OF *MERHIPPOLYTE* (DECAPODA NATANTIA) FROM EAST AMERICAN WATERS

BY

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mong unidentified Decapoda in the collection of the United States National eum, Washington, D.C., four specimens of a species of *Merhippolyte* were id, which proved to be new to science. The material was collected by the mer "Albatross" in deeper waters off the east coast of America. Until now the is *Merhippolyte* was only known from South Africa, India and Hawaii.

nother interesting feature of the present species is that though it is new in the e that it has not been described before as a distinct species, a description and gure of it have been published as long ago as 1930. Boone (1930: 135, pl. 46) gave a reasonably good figure and a two-page description, based on two ale specimens which had been dredged by the "Ara" off Alligator Reef, ida. Though the description and the figure clearly show the hippolytid nature he species, Boone assigned her material to the oplophorid *Systellaspis debilis* Milne Edwards), an error which until now has remained uncorrected.

Merhippolyte americana new species

laspis debilis, Boone, 1930: 135, pl. 46 (not *Acanthephyra debilis* A. Milne Edwards, 1881)

U.S. National Museum

f Cape Lookout, North Carolina, 34° 39′ 15″ N 75° 33′ 30″ W; depth 107 fathoms; bottom sand and pebbles; 18 October 1885; "Albatross" Sta. 2601. — 1 specimen, cl. 6 mm.

catan Channel, 20° 59′ 30″ N 86° 23′ 45″ W; depth 130 fathoms; bottom coral; 22 January "Albatross" Sta. 2354. — 3 specimens, cl. 5-6 mm.

escription. In all four specimens at my disposal the rostrum is broken. In the imen in which the rostrum is least damaged, it extends distinctly beyond the hocerite and is upturned. The upper margin bears four strong teeth, the first hich is placed behind the posterior limit of the orbit, while the second stands over the orbit. The other teeth are placed in the proximal part of the rostrum, distal half of the upper margin being entire. The lower rostral margin in best preserved specimen bears seven teeth which are placed rather close toer and extend all along the distal part of the margin. The carapace is smooth. rong antennal spine is situated just below the lower orbital angle. No other es are present. The pterygostomian angle is broadly rounded.

The abdomen is smooth. The pleura of the first four somites are broadly ro ed. The third somite is somewhat posteriorly produced in the posteromedian The fifth somite has the pleura ending in a small but acute posteriorly dire tooth. The sixth somite is about twice as long as the fifth; it possesses at the of the uropods a distinct tooth, which is not movable. The telson is slightly sh than the sixth abdominal somite. It bears two pairs of dorsal spines; the ante of these lies in the middle of the telson, the posterior is situated slightly cl to the anterior pair than to the posterior margin. This posterior margin end a sharp median point which at each side is flanked with three spines, the o of which are small, the median are the longest and strongest, while the inner is shorter than the median and more slender than both the outer and me pairs; the inner spines are hairy. The posterior half of the telson bears a fr of flexible hairs on the lateral margin.

The eyes are large and globular. The cornea is longer and much broader the stalk. An ocellus is visible, but it is almost entirely fused with the cor

The basal segment of the antennular peduncle has the stylocerite very str it reaches almost to or slightly beyond the end of the segment and is about as broad as the segment proper. At the base of its outer margin the styloc bears a distinct tooth. The stylocerite itself ends rather abruptly in a small to The second and third segment are short, together they still are distinctly sh than the basal segment. The third segment is somewhat shorter than the sec There are two flagella, the upper of these has the basal articles (about 2 number) thickened.

The scaphocerite is about five times as long as broad. The lamella disti overreaches the final tooth.

The mandible consists of an incisor and a molar process. The incisor pr is small and provided near the top with minute teeth. The molar process b rows of spinules or short setae on the knobs. A three-jointed palp is present. maxillula has the upper lacinia rather broad, the lower lacinia is smaller and m narrower; the palp ends in two or three points, each of which bears a long The endite of the maxilla is cleft into two rather broad lobes, the palp and scaphognathite are well developed. The endites of the basis and coxa of the maxilliped are separated by only a small notch; the palp consists of 3 arti the exopod is well developed and is provided with a distinct caridean lobe; epipod consists of two rather diverging lobes. The second maxilliped is of usual shape, it bears a strong keel on the posterior (= ventral) surface o ischium; the exopod is well developed, the epipod is provided with a podobra The third maxilliped reaches beyond the end of the antennular peduncle, but to attain the end of the scaphocerite. The ultimate segment is almost twice as as the penultimate and about $^2/_3$ as long as the antepenultimate. A well devel exopod is present, it reaches slightly beyond the middle of the antepenulti segment. A distinct elongate epipod and two arthrobranchs are placed in the b part of the maxilliped.

The branchial formula is as follows:

	maxillipeds			pereiopods				
	1	2	3	1	2	3	4	5
urobranchs	—	—	—	1	1	1	1	1
hrobranchs	—	—	2	1	1	1	1	—
dobranchs	—	1	—	—	—	—	—	—
pods	1	1	1	1	1	1	—	—
pods	1	1	1	—	—	—	—	—

The first pereiopods are chelate and rather robust, they are equal in shape, ching about to the end of the antennular peduncle. The fingers are distinctly rter than the palm and have their tips provided with some tufts of short setae. e palm narrows slightly anteriorly. The carpus is about as long as the chela. e peculiar groove in the carpus of the first legs as described by Kemp & Sewell 912) for *Merhippolyte calmani* Kemp & Sewell, also is present in the American cies. The merus is 1.5 times as long as the carpus. The ischium is short, but rs at the lower side an apical sabre-shaped process, which extends along the ver margin of the merus about to the middle of that segment. The second legs equal or nearly equal in shape. They reach to or slightly beyond the end of the phocerite. The chela is small and its fingers are shorter than the palm. The pus is about 4.5 times as long as the chela and consists of 13 or 14 articles, distal one being considerably longer than the preceding. The merus is half long as the carpus and slightly shorter than the ischium. The last three pairs of s reach almost to or slightly beyond the end of the scaphocerite. They are very ilar in shape. In the third leg the dactylus ends in two teeth and bears three four spinules on the posterior margin. The propodus is about five times as g as the dactylus. It bears about eight slender spinules on the posterior margin. e carpus is about half as long as propodus and dactylus combined. The merus somewhat longer than the propodus; it bears two strong spines on the outer face: one close to the distal margin, the other also in the anterior half. The ium is less than half as long as the merus. In the fourth and fifth legs the rus bears a third spine on the outer surface, namely in the proximal half.

The endopod of the first pleopod of the male shows an appendix interna with inacula, which is implanted on the inner margin somewhat below the top. The ond pleopod of the male has the appendix masculina slightly longer than the endix interna; it bears numerous strong and rather long setae. The outer margin the uropodal exopod ends in a tooth which at its inner side bears a movable nule.

The eggs are rather numerous; they are 0.43 to 0.67 mm in diameter. The only gerous female of the examined material was found in the lot from Yucatan annel.

Type. Holotype is the male specimen from "Albatross" Sta. 2354 (Yuc
Channel), the other specimens are paratypes.

Distribution. The species is now known from three localities off the east
of America: Boone's (1930) specimens came from 7 miles off Alligator

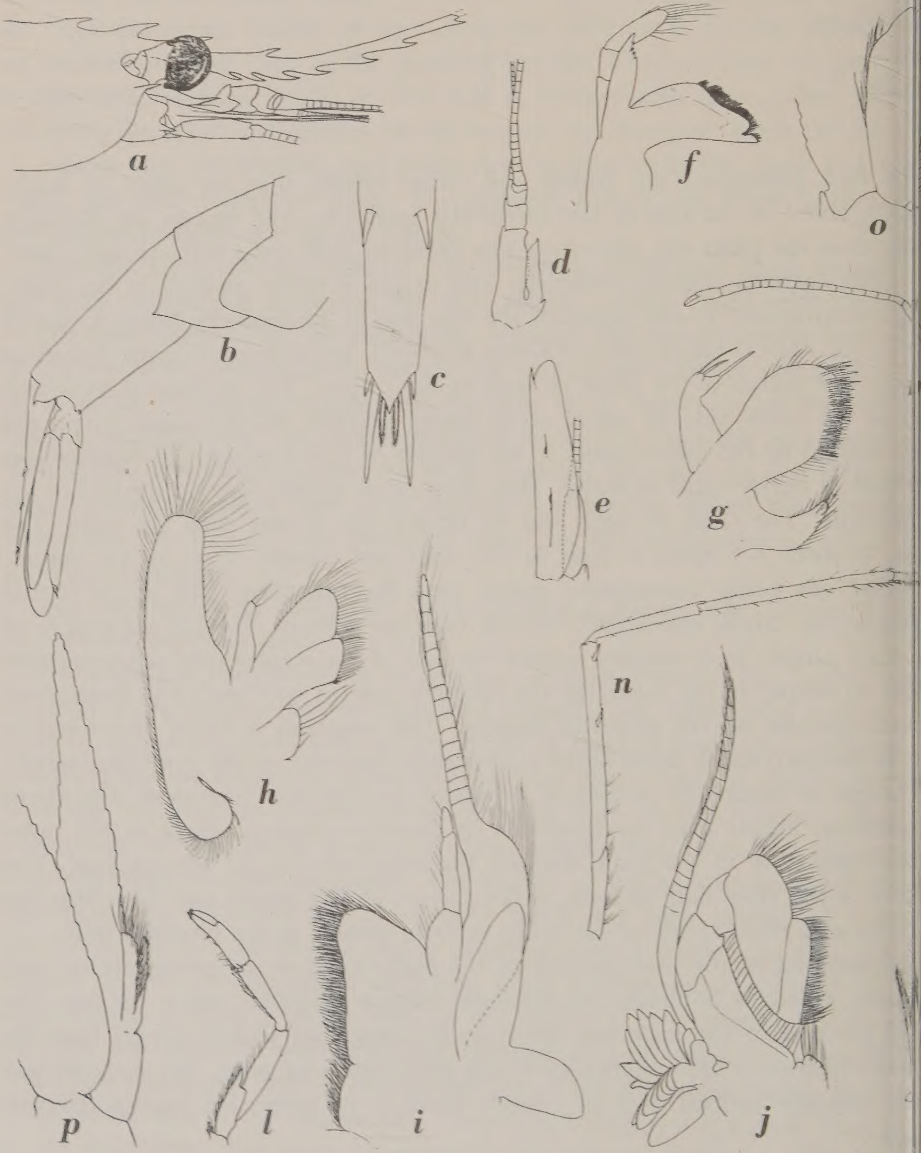

Fig. 1. *Merhippolyte americana* new species. a, anterior part of body in lateral view; b, pos
part of abdomen in lateral view; c, tip of telson in dorsal view; d. antennula; e, scapho
f, mandible; g, maxillula; h, maxilla; i, first maxilliped; j, second maxilliped; k, third maxil
l, first pereiopod; m, second pereiopod; n, third pereiopod; o, endopod of first pleopod of
p, endopod of second pleopod of male. a, b, d, e, × 5; c, f, g, i, j, o, p, × 20; h, × 16; k-n,

Florida; the present specimens are from off Cape Lookout, North Carolina. l from Yucatan Channel, Mexico. The species inhabits moderately deep water, ng collected at 107, 130, and 150 fathoms.

Merhippolyte americana is the fourth species of the genus *Merhippolyte* known present. The other species are *Merhippolyte agulhasensis* Bate from S. Africa, *calmani* Kemp & Sewell from South African and Indian Seas, and *M. kauaien-* (Rathbun) from the Hawaiian Archipelago. *M. americana* differs from both *calmani* and *M. agulhasensis* in that the fourth pereiopod does not bear an pod, while in *M. kauaiensis* epipods are found only on the first two pereiopods. *M. calmani* and *M. kauaiensis* the rostrum bears only three dorsal teeth; in *agulhasensis* this number varies between 4 and 6, so that the present new cies in this respect resembles the latter species most. The pterygostomian angle the carapace in *M. agulhasensis* is rectangular or bears a tooth, while in *M. nani* it is rectangular; in both *M. kauaiensis* and *M. americana* this angle is adly rounded.

RÉSUMÉ

es Caridea identifiés par Boone (1930: 135, pl. 46) comme *Systellaspis debilis* (A. Milne ards) n'appartiennent pas à cette espece et même pas à la famille des Oplophoridae, mais tituent une nouvelle espèce de *Merhippolyte* (fam. Hippolytidae), dont la description est donnée Les deux spécimens décrits et figurés par Boone avaient été recueillis à 7 milles devant Alli- r Reef, Floride, à une profondeur de 150 brasses. Le Muséum National des États Unis possède re spécimens de cette espece pris par l'"Albatross" devant la côte atlantique de la Caroline Nord et dans la détroit de Yucatan, à 107 et 130 brasses de profondeur. C'est la première fois le genre *Merhippolyte* est signalé des eaux américaines.

nouvelle espèce se distingue des autres especes du genre par le nombre des péreiopodes qui ent un épipode, par le nombre des dents dorsales du rostre et par la forme de l'angle ptéry- mien de la carapace.

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THE LARVAL DEVELOPMENT OF *EURYPANOPEUS DEPRESSUS* (SMITH) UNDER LABORATORY CONDITIONS [1])

BY

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Duke University, Durham, N.C.

INTRODUCTION

Although the larvae of crabs within the family Xanthidae have received n attention than larvae from any other single group, many species have been scribed only in part. Hyman (1925), describing the larvae of xanthid crabs f the Beaufort, North Carolina, area, figures only the first zoea of *Eurypano depressus,* although he comments that he identified the remaining larval st from planktonic material. Birge (1883) also mentions only the first zoea of species. Both Birge (1883) and Hyman (1925) give diagnostic characters the separation of first zoea of *Eurypanopeus depressus* and *Neopanope texana* Hyman's (1925) main criterion for this separation, in all stages, was the differ in chromatophore pattern. Because chromatophore patterns can differ in f material and in living material (Costlow and Bookhout, 1960) additional phological characters would be of value for the identification of larvae o *depressus.*

The objectives of the present study have been twofold: (1), to rear the la of *Eurypanopeus depressus* (Smith) from hatching to the first crab and detern the number of larval stages which completes the development of this crab; (2), to provide a description of all larval stages of *Eurypanopeus depressus* wh may serve as a basis for identification of larvae of this species and separation f similar larvae of closely related species.

The authors wish to express their appreciation to Mrs. W. A. Chipman Mrs. C. C. King for their assistance throughout the study. We also thank Fenner A. Chace, U. S. National Museum, for the identification of the fem from which the larvae were obtained.

MATERIAL AND METHODS

Ovigerous females of *E. depressus* were segregated in finger bowls contain sea water of the following salinities: 12.5, 20.1, 26.7 and 31.1 p.p.t. Prior

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[1]) These studies were aided by a grant (G 4400) from the National Science Foundation.

ching the water was changed daily. At the time of hatching the zoeae were noved to separate bowls containing sea water of the same salinity, segregated o groups of 10 zoeae per bowl, and fed on *Artemia* nauplii and *Arbacia* eggs. e larval stages were maintained at temperatures of 20°C., 25°C., and 30°C. h a photoperiod of 12 hours of light and 12 hours of darkness. Approximately 00 zoeae were originally segregated within all salinity-temperature conditions. e larvae were changed daily to freshly filtered sea water and clean receptacles, food supply renewed, and the number of molts recorded. Larvae were fixed known intervals of development in Bouin and 70 per cent alcohol and exuviae re kept in 70 per cent alcohol to check setation of appendages.

Drawings were made to scale with the aid of a Whipple disc mounted in the ular of a compound microscope. The appendages were dissected from each stage vae and drawn to a different scale from that used for drawing the whole vae. Chromatophore patterns for the zoeae and megalopae were drawn from ing larvae anesthetized with ethyl urethane.

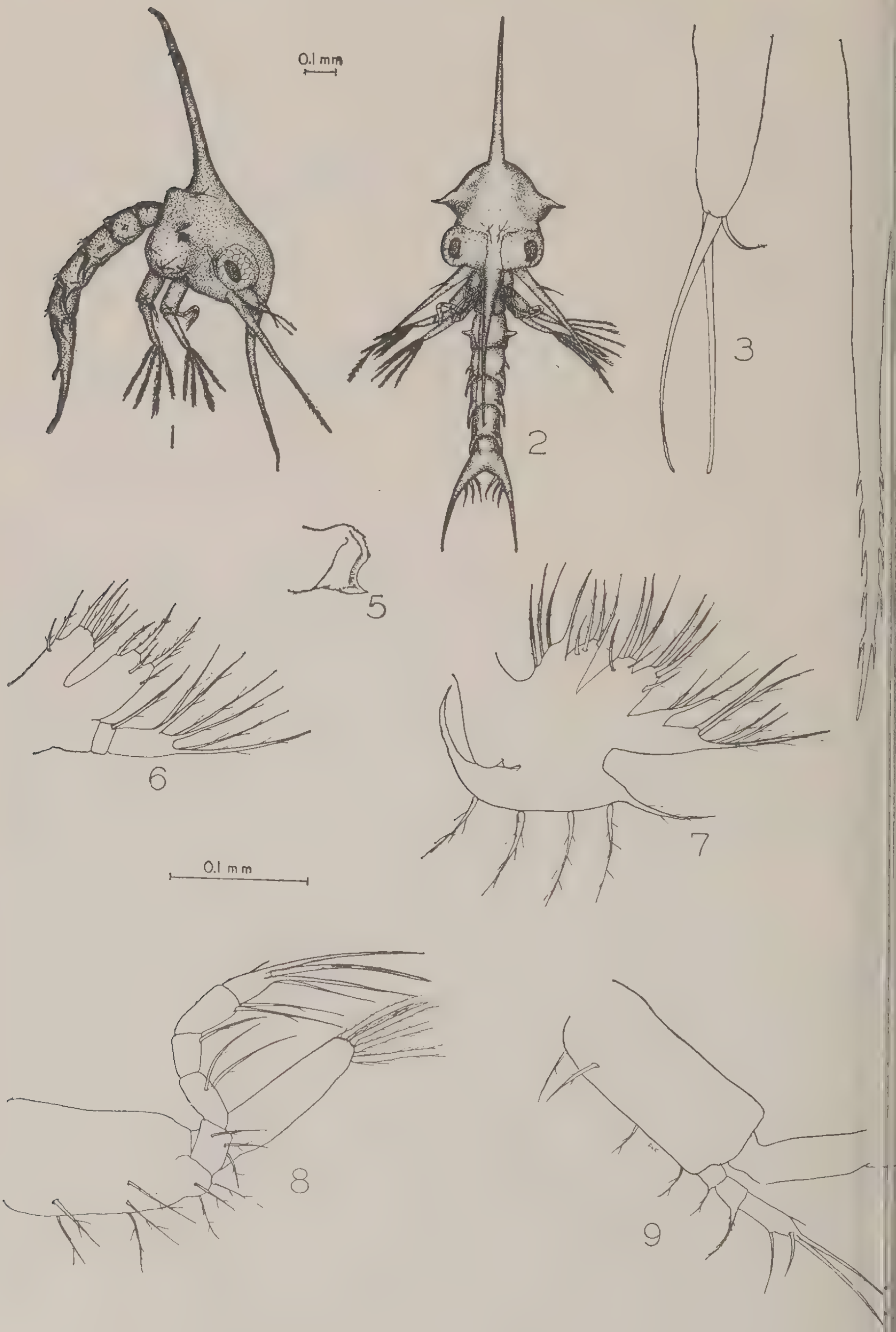
RESULTS

Under laboratory conditions there are 4 zoeal stages and one megalopa stage the development of *Eurypanopeus depressus.* Variation in number of larval ges was not observed. The main morphological characteristics for each larval ge are as follows.

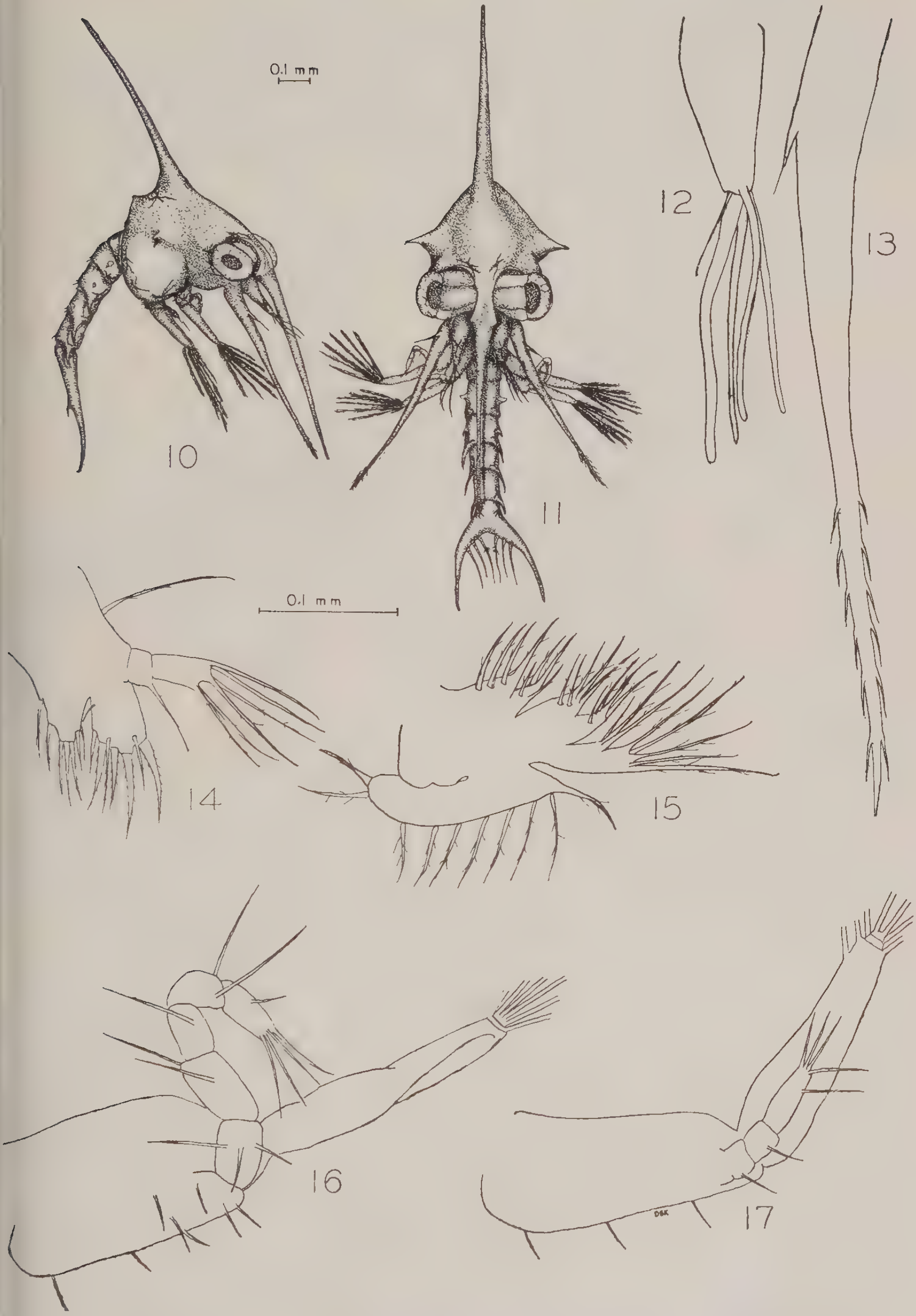
First zoea: The cephalothorax (figs. 1 and 2) has dorsal, rostral, and lateral nes. The dorsal spine terminates as a slender hook and the dorsal spine is approximately equal in length to the antennae. There are 5 abdominal segments and telson. On abdominal segment two the lateral surfaces give rise to a short ne which curves anteriorly. The third abdominal segment bears a smaller hook each lateral surface. The postero-lateral margins of abdominal segments 3 ough 5 terminate as spines which overlap the next segment. Projecting from dorsal surface of each segment is a pair of small setae. The telson (fig. 1) a small dorsal spine on each prong, but no lateral spine, and three pairs of nes are found on the inner surface of the telson.

The distribution of chromatophores in the living larvae is as follows: (1), rsal and median to each eye; (2), posterior and ventral to each eye; (3), dorsal heart; (4), mandibles and labrum; (5), antennules; (6), basipodite of first d second maxillipeds; (7), postero-lateral margins of cephalothorax; (8), first dominal segment, median and dorsal to gut; (9), abdominal segments 2 through postero-lateral surface; and (10), telson.

The antennule (fig. 3) has two terminal aesthetes and one smaller seta. The topodite of the antenna (fig. 4) forms a tapering process which bears short nes on the distal surface. The minute exopodite bears one short spine. The ndible (fig. 5) has several small teeth on the cutting surface and one large ntral tooth. The endopodite of the maxillule (fig. 6) has 4 terminal setae, two terminal setae, and one seta projects from the basal segment. The basal endite



Figs. 1-9. *Eurypanopeus depressus* (Smith), first zoea. — Fig. 1, lateral view. — Fig. 2, frontal — Fig. 3, antennule. — Fig. 4, antenna. — Fig. 5, mandible. — Fig. 6, maxillule. — Fi maxilla. — Fig. 8, first maxilliped. — Fig. 9, second maxilliped.


0.1 mm
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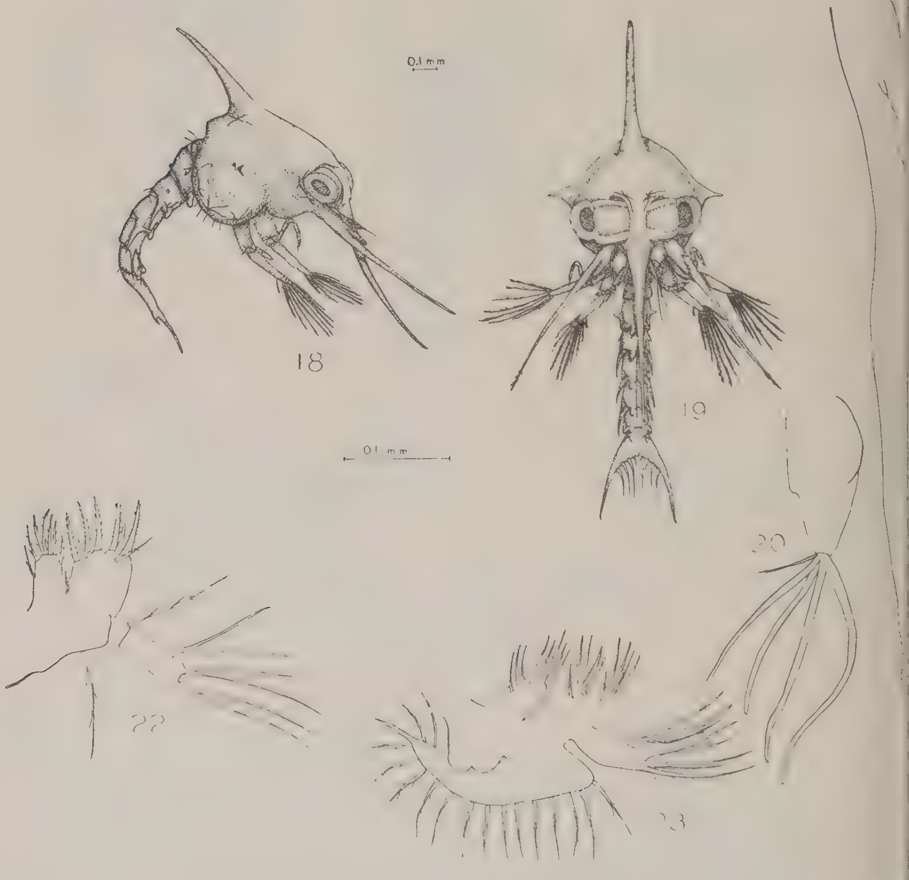
s. 10-17. *Eurypanopeus depressus* (Smith), second zoea. — Fig. 10, lateral view. — Fig. 11, ntal view. — Fig. 12, antennule. — Fig. 13, antenna. — Fig. 14. maxillule. — Fig. 15, maxilla. — Fig. 16, first maxilliped. — Fig. 17, second maxilliped.

has 5 spines and 7 spines project from the coxal endite. The unsegmented e
podite of the maxilla (fig. 7) has three terminal setae, two smaller subterm
setae, and a more basal group of three setae. The basal endite has a total
spines and the coxal endite bears 8 spines. Five soft hairs project from the
margin of the scaphognathite. Four swimming setae are found on the exopo
of the first and second maxillipeds (figs. 1 and 2). Setation of the five-segme



Figs. 18-23. *Eurypanopeus depressus* (Smith), third zoea. — Fig. 18, lateral view. — Fi
frontal view. — Fig. 20, antennule. — Fig. 21, antenna. — Fig. 22, maxillule. — Fig. 23, ma

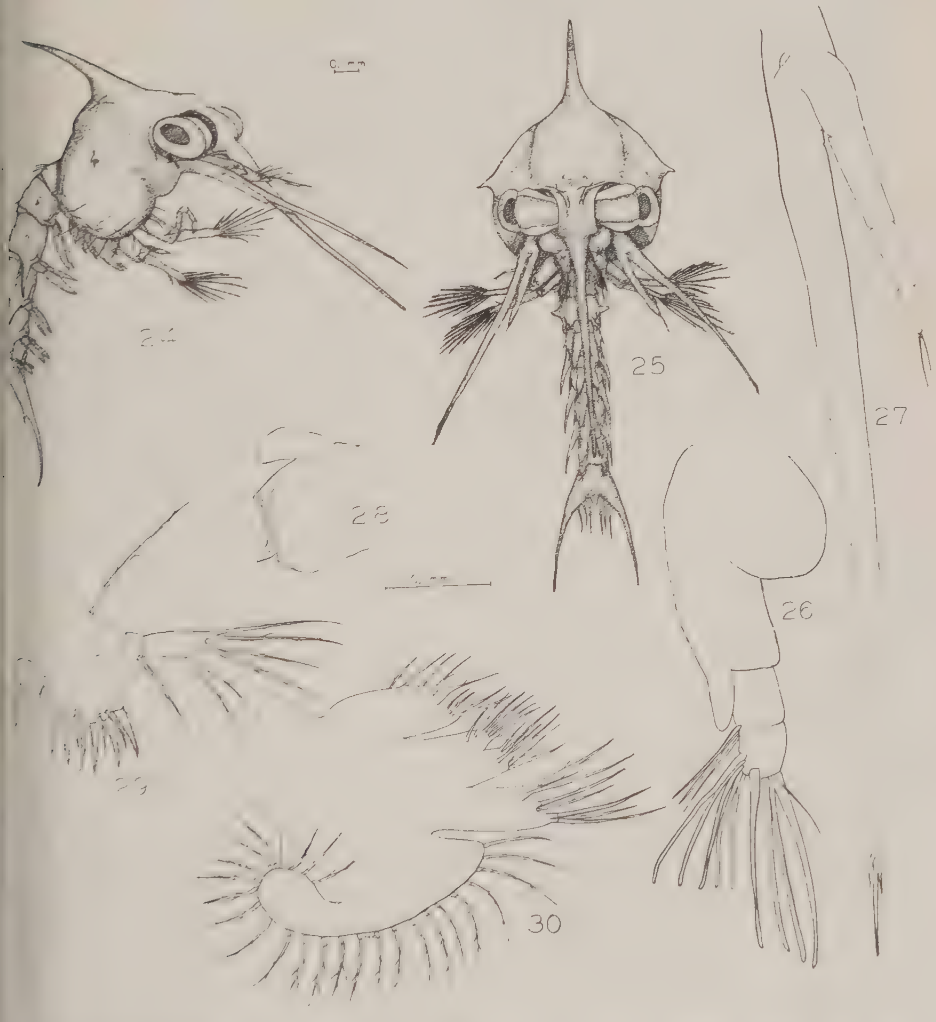
endopodite of the first maxilliped is 3, 2, 1, 2, 5 (fig. 8) and the three-segm
endopodite of the second maxilliped has a setation of 1, 1, 5 which does not ch
throughout zoeal development (fig. 9).

Second zoea (figs. 10 and 11): The basal portion of the antennule (fig.
is slightly swollen and 4 terminal aesthetes and one seta are present. The
and coxal endites of the maxillule each have 7 spines (fig. 14). Eight hair
present on the distal surface of the scaphognathite and there are two hairs o

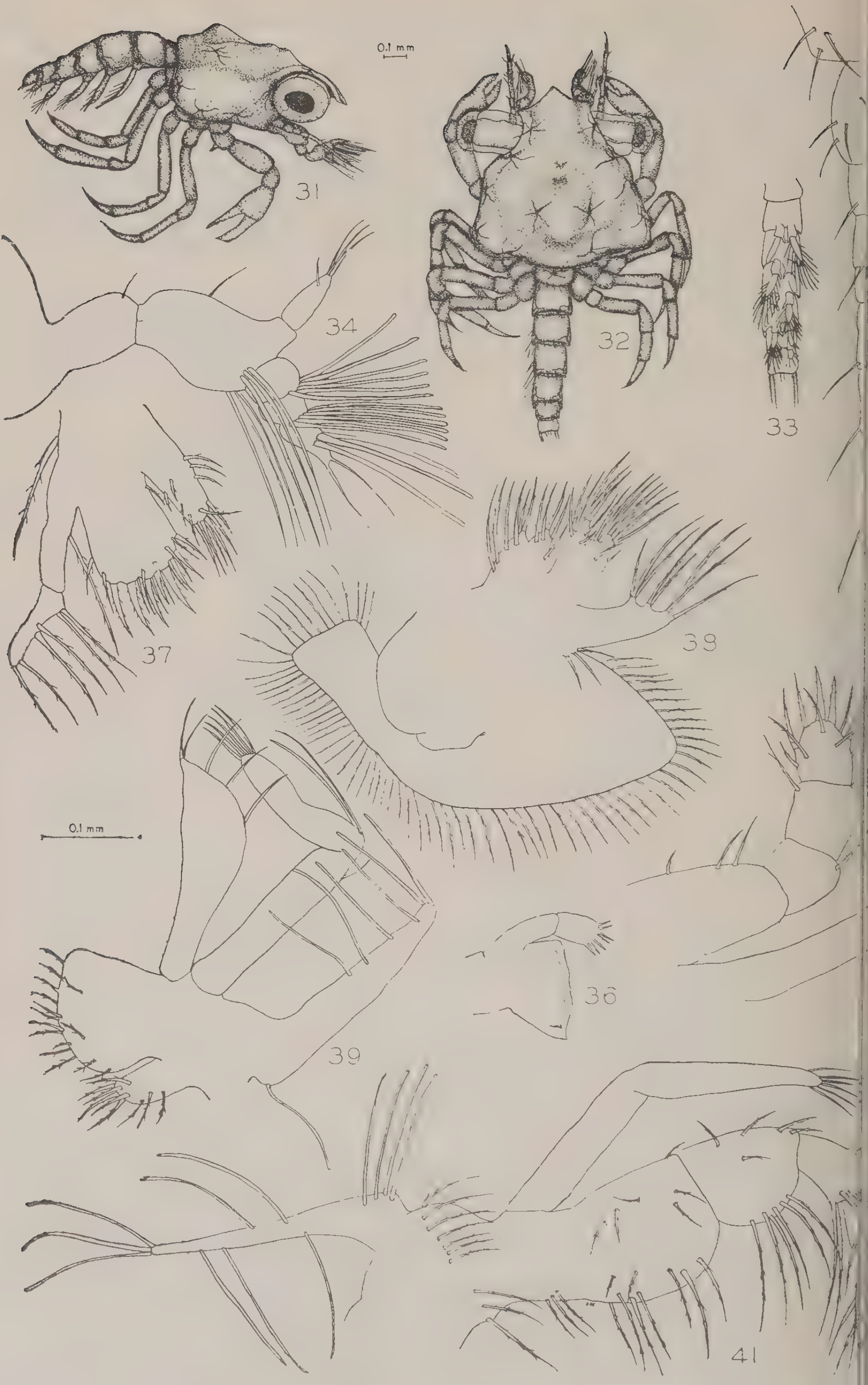
al tip (fig. 15). The exopodites of maxillipeds one and two have 6 and 7 nming setae respectively (figs. 16 and 17).

hird zoea: The thoracic appendages and the third maxilliped appear as small s beneath the carapace (fig. 18) which is now fringed with short hairs. A abdominal segment is added and all segments bear small pleopod buds on ventral surface (figs. 18 and 19). On the inner surface of the telson a small of spines is added.

the swollen basal region of the antennule (fig. 20) the endopodite appears small bud. The endopodite of the antenna (fig. 21) is also present. Setation he basal endite of the maxillule has increased to 8 and the coxal endite has



24-30. *Eurypanopeus depressus* (Smith), fourth zoea. — Fig. 24, lateral view. — Fig. 25, al view. — Fig. 26, antennule. — Fig. 27, antenna. — Fig. 28, mandible. — Fig. 29, maxillule. — Fig. 30, maxilla.


0.1 mm
31
32
33
34
38
37
0.1 mm
36
39
41

Figs. 31-41. *Eurypanopeus depressus* (Smith), megalopa. — Fig. 31, lateral view. - Fig. 32, view. — Fig. 33, abdomen, ventral view. - Fig. 34, antennule. — Fig. 35, antenna. — F mandible. - Fig. 37, maxillule. — Fig. 38, maxilla. — Fig. 39, first maxilliped. — F second maxilliped. — Fig. 41, third maxilliped.

ines (fig. 22). The basal endite of the maxilla has 10 spines and the coxal
te has 8 spines (fig. 23). Setation of the endopodite of the first maxilliped
2, 1, 2, 6 with 8 setae on the exopodite (fig. 18). The exopodite of the
nd maxilliped has 9 swimming setae (fig. 19).

urth zoea: The hairs fringing the lateral borders of the carapace are more
erous and the thoracic appendages now project below the border of the cara-
(figs. 24 and 25). The segmented antennule bears three tiers of aesthetes
nged as 3, 5, 4 (fig. 26). A smaller seta also projects from the terminal seg-
t. The endopodite of the antennule is present as a small knob. The endopodite
ne antenna (fig. 27) has increased in length, shows slight segmentation, and
inates as two small hairs. The mandible now bears a palp on the dorsal
ace (fig. 28). Setation of the basal and coxal endites of the maxillule has
ased to 10 and 8 respectively (fig. 29). Twelve spines project from the basal
te of the maxilla and the coxal endite has 9 spines (fig. 30). The exopodite
ne first maxilliped has 9 swimming setae and 11 setae project from the exo-
te of the second maxilliped (fig. 24). A ninth spine is added to the inner
ace of the telson.

egalopa: The rostrum terminates as a blunt, median process which is deflected
nwards (figs. 31 and 32). There are numerous short hairs on the carapace
thoracic appendages. Pleopods are present on abdominal segments 2-6 with
ation of 13, 12, 11, 9 and 5 (fig. 33). On some specimens the pleopods of
nent 5 and 6 had 10 and 6 setae respectively. Three small hairs project cau-
from the posterior edge of the telson and each side has an additional pair
nger hairs (fig. 32). On the basi-ischiopodite of the chela (fig. 31) is a stout
which is deflected posteriorly.

ne chromatophore pattern of the megalopa (figs. 31 and 32) is as follows:
median to eyes, extending on to rostrum; (2), posterior to eyes; (3), post-
lorsal surface of carapace; (4), lateral and posterior margins of cephalothorax;
first abdominal segment, dorsal to gut; (6), postero-lateral borders of ab-
inal segments 2-6.

ne unsegmented flagellum of the antennule (fig. 34) bears three terminal and
subterminal setae. On the segmented flagellum the three tiers of aesthetes
rranged as 6, 6, 3 and the terminal segment also has two setae (fig. 34).
nine segments of the antenna bear setae as shown in figure 35. The mandible
36) has a two-segmented palp bearing 7 spines on the terminal segment.
ion of endites of the maxillule (fig. 37) of the megalops is variable. The
gmented endopodite of the maxilla (fig. 38) has three terminal setae, two
erminal setae, and three additional setae more basally. Setation of the basal
coxal endites is variable. Numerous hairs fringe the scaphognathite. Setation
ne first, second, and third maxillipeds is as shown in figures 39, 40 and 41.

DISCUSSION

Within the Brachyura the larval development of the Xanthidae has recei considerable attention for the past 80 years. Birge (1883) described the la stages of *Neopanope texana sayi* and Hyman (1925), studying the same spe at Beaufort, North Carolina, mentions the points on which his description dif from that of Birge (1883). More recently the larvae of this species have been r ed in the laboratory (Chamberlain, 1957) but not described. Hyman (1925) included descriptions of "pre-zoeae" and first stage zoeae, obtained from hatch the eggs, and later larval stages, obtained from the plankton, of several spe from the family Xanthidae (*Eurypanopeus depressus*; *Panopeus herbstii*; *H panopeus angustifrons*; *Xantho* sp.; *Eriphia spinifrons*; *Menippe mercenaria*; *Pilumnus* sp.). Cano (1891) had previously described the zoeae of unidenti species of *Xantho* and *Pilumnus*. Lebour (1928) figures and describes vari larvae from additional species of this group found at Plymouth (*Xantho inci Xantho hydrophilus*; *Pilumnus hirtellus*). Connolly (1925) described the la stages of *Rhithropanopeus harrisi* from planktonic material and larvae of species of *Lophopanopeus* have been reared in the laboratory (*L. bellus*, H 1935; *L. leucomanus leucomanus*, Knudsen, 1958). The complete larval deve ment of another abundant species at Beaufort, N.C., *Panopeus herbstii*, has been described from laboratory rearing (Costlow and Bookhout, 1960).

Differentiation of living zoeae of *Panopeus herbstii* (Costlow and Bookh 1960) and *Eurypanopeus depressus* is possible on the basis of the chromatoph of the antennules in larvae of *E. depressus*. In fixed material, where chrom phores may not show distinctly, the progressive increase in setation of endite the maxillule is different in larvae of the two species and may be used as a d nostic character. The absence of a lateral spine on each prong of the telson o *depressus* zoeae also serves to distinguish larvae of this species from zoea *P. herbstii*. *Neopanope texana sayi* (Hyman, 1925), however, also lacks a lat spine on the telson and, in an area where *E. depressus* and *N. texana sayi* common, the differentiation of larvae may prove to be difficult.

The megalopa stage of *E. depressus*, although quite different from the megal of *P. herbstii* (Costlow and Bookhout, 1960) is superficially similar to the m lopa described for *N. texana sayi* by Hyman (1925). It is possible, however, a more detailed description of *N. texana sayi* megalopa will also permit diffe tiation of larval stages of these species.

The effects of salinity and temperature on larval development of *E. depre* will be discussed in a separate account.

SUMMARY AND CONCLUSIONS

The larval development of *Eurypanopeus depressus* (Smith) has been followed in the labora from hatching to the first stage crab and beyond. Approximately 1200 larvae were maintaine *Artemia* nauplii and fertilized *Arbacia* eggs at four salinities (12.5, 20.1, 26.7, and 31.1 p.p.t.) three temperatures (20° C., 25° C., and 30° C.). From these studies the following conclus may be made:

. There are four zoeal stages and one megalopa stage in the complete development to the first stage. These are figured and described.

. The setation of all functional appendages has been described and figured for each larval stage. re is a progressive increase in setation of the endites of the maxillule as development progresses. tion of these appendages may serve to distinguish the zoeae of *E. depressus* from zoeae of *P. bstii.* In living zoeae, the presence of chromatophores in the antennules of *E. depressus* may also used to differentiate the zoeae from those of *P. herbstii.*

. Although the megalopa of *E. depressus* may be distinguished from the megalopa of *P. herbstii,* erentiation of larval stages of *Neopanope texana sayi, E. depressus,* and *P. herbstii* will require ore complete description of the larvae of *N. texana sayi.*

ZUSAMMENFASSUNG

ie Larvalentwicklung des Dekapoden *Eurypanopeus depressus* (Smith) wurde im Laboratorium Schlüpfen bis zum ersten Krabbenstadium und darüber hinaus verfolgt. Die vollständige Ent- klung bis zum ersten Krabbenstadium umfasst 4 Zoëa-Stadien und 1 Megalopa-Stadium. Die ven und die funktionellen Körperanhänge werden beschrieben und abgebildet. Die Beborstung Enditen der Maxillula (1. Maxille) nimmt zu mit jedem Entwicklungsstadium und ermöglicht Unterscheidung der *E. depressus* Zoëae von *Panopeus herbstii* Zoëae. Die Anzahl der Larven- ien blieb konstant wenn die Larven unter verschiedenen Salzgehalt-Temperatur-Kombinationen ichtet wurden.

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FINE STRUCTURE OF SPERM TAILS OF ISOPODS

BY

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INTRODUCTION

Electron microscopy has revealed a remarkable uniformity in the fine struct
of motile spermatozoa from animals as diverse as protozoa, molluscs, echinode
and vertebrates. Sperm tails in most phyla, like other flagella and cilia of b
plants and animals, consist essentially of a cylinder of nine double fibrils enclos
a central pair, the axis so formed being embedded in a structureless matrix
bounded by a limiting membrane (Bradfield, 1955). Among the Crustacea, h
ever, certain anomalous types have been found (see Discussion). In view of
apparent lack of motility of isopod sperm tails, and their comparative length
resiliency, it was considered of interest to examine representative specimens ur
the electron microscope. Three species were investigated by this means: *Idotea*
thica (Pallas) (marine), *Cyathura* sp. (from brackish water) and *Oniscus asell*
(terrestrial). Several specimens of *Asellus militaris* (Hay) (a fresh-water spec
were examined, but the vasa deferentia were found to contain only appare
immature sperm, without tails. In addition, tailed sperm of the fresh-water am
pod *Gammarus fasciatus* Say were examined by the light microscope, but mat
embedded and sectioned proved unsatisfactory for electron microscopy.

METHODS

Whole spermatozoa from vasa deferentia of *Cyathura* were fixed in 10%
malin, washed with distilled water, allowed to dry on a formvar membrane
ported on a fine-mesh grid, and directly examined under the electron micros
(RCA model EMU-2).

Vasa deferentia containing ripe sperm were dissected from adult males, f
with 1% osmium tetroxide in veronal buffer and isotonic saline, washed, d
drated in a propanol series, and imbedded in a 3 : 1 mixture of butyl and me
methacrylate. Thin transverse and longitudinal sections were cut with a sp
microtome (Philpott, 1955) and examined under the electron microscope.

OBSERVATIONS

In each case the sperm tails are long (up to 1 mm in *Cyathura*), cylindr

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ugh tapered distally to a fine point, and resilient. Although kinks were occa-
ally noted in *Oniscus* and *Gammarus,* motility was not observed in any of
species we examined.

lectron microscopy reveals the structure to consist of a series of discs, seen
longitudinal section as transverse bands or striations of various thicknesses and
tron densities, with a regularly repeating periodicity. A segmented central
e 40-50 mμ wide, with denser walls and a less dense medulla, is evident in
dian longitudinal and in transverse sections. A summary of measurements is
en in Table I.

TABLE I

Axial and band widths (± 2 mμ) of isopod sperm tails.

	Cyathura	*Idotea*	*Oniscus*
	mμ	mμ	mμ
meter of tail axis	300	400	240
eating period	63	57	62

The whole mount of *Cyathura* sperm (fig. 1) shows the tail axis enclosed in a
ath of less dense material, which exhibits transverse bands corresponding to
se of the axis itself. In the course of drying, this sheath presumably flattened
to appear wider than in life. The longitudinal sections (fig. 2) show that each
eating period consists of four bands, with the following approximate widths:
k 18 mμ, intermediate density 16 mμ, pale 12 mμ, intermediate 16 mμ. The
e central medulla tends to be interrupted in the region of the darkest bands,
l to widen in the proximal region near the head (figs. 3-6).

n *Idotea* (figs. 7, 8) each repeating period also appears to consist of four bands:
e 16 mμ, dark 8 mμ, intermediate 20 mμ, dark 8 mμ. A thin, pale streak is
asionally visible in the middle of the intermediate band. It would be premature
attempt to homologize this band pattern with that of *Cyathura.* The cross sec-
ns, however, are similar.

In *Oniscus* (fig. 9) each period comprises three faint and one darker band
ut 8 mμ wide, equally spaced along a pale background. Since our preparations
this species were less satisfactory than the others, these details were unclear.
ss sections resemble those of the other two isopods; but here they show the
rm associated in bundles of about ten (Retzius, 1909; Vandel, 1934).

DISCUSSION

The spermatozoa of crustaceans include a variety of unusual and bizarre forms.
ough published data are scattered and fragmentary, the following generalizations
y be made (cf. Retzius, 1909):

1. Motile spermatozoa of unique construction and extreme length (as long
10-20 mm!) occur in the sub-class Ostracoda (Lowndes, 1935). Those of
todromas have been examined with the electron microscope (Bradfield, 1955).

2. Spermatozoa with tails and active motility occur in the sub-classes Branch and Cirripedia. Preliminary electron microscope studies of barnacle sperm (Dr Barnes, personal communication) indicate that they consist of fibrils simila those of other animals.

3. Tail-less spermatozoa occur in the sub-classes Branchiopoda and Copepoda

4. Among the Eumalacostraca, tail-less sperm occur in the Eucarida (euphau and decapods [3]) and the Hoplocarida (stomatopods), and tailed sperm in Peracarida (isopods, amphipods, mysids and cumaceans). In the latter divis however, the tails are wholly unlike those of sperm from other animals. T are relatively long (often exceeding 1 mm), resilient or pliant, and normally n motile.

Retzius (1909) reported that he had been unable to observe movement in sperm of any of the Peracarida examined, and this has been the general experi (e.g. in *Trichoniscus;* Vandel, 1934). We likewise observed no movement in species of isopod, nor in the amphipod *Gammarus.* Among the amphipods, h ever, there is a record of worm-like movement of the heads of caprellid sp (Reibisch, 1926, p. 782), and of a slow vermiform movement in the tail *Talitrus* sperm when in close proximity to eggs removed shortly after their charge into the brood pouch (Williamson, 1951). Since Lowndes (1935) served motility of ostracod sperm only within the spermathecae of female anim it is possible that isopod and other crustacean sperm may be found to be m if suitable physiological conditions are provided. In isopods the sperm tails play no direct role in propulsion, but may serve as "handles" to facilitate the chanical transfer of sperm bundles by the specially modified 2nd pleopod the male. In this connection it should be mentioned that, even in mammals, autonomous motility of spermatozoa may play a less important role in their tr location than is generally supposed (Hartmann, 1957).

The extreme conservatism of sperm tail construction in other classes of animal kingdom suggests that the fine structure of crustacean sperm tails provide valuable clues to phylogenetic affinities. The sperm tails in other gro of the Peracarida, and in the Syncarida, might prove of special interest in connection.

A regular periodicity of light and dark bands is characteristic of collagen fib with a periodicity of 64 mμ (see review by Banfield, 1958), and of paracry of certain fibrous proteins such as paramyosin, with a period of 72 mμ (Hall *et* 1945). Of perhaps more immediate pertinence is the transverse striation of intracellular rootlets of cilia in many organisms (e.g. annelids, molluscs), wh the repeating period of 66-70 mμ is subdivisible into several bands, like that collagen (Banfield, 1958). In particular, the single ciliary rootlets of the coel ites *Mussa* (period, 67 mμ; Goreau & Philpott, 1956) and *Metridium* (period, mμ; Grimstone *et al.*, 1958) appear to be organically continuous with the basal nule of the cilium, and to show indications of a less dense central core. Thus some respects they resemble the sperm tails of isopods described above, though periodic bands have not been resolved further into distinguishable subdivisions. ce evidence from a variety of recent studies suggests a homology between basal nules and centrioles, it is significant that the sperm tails of *Asellus nipponensis,* those from animals of other phyla, apparently arise from one of the centrioles giyama, 1933).

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[3] The sperm cells of penaeids bear a short, fine process, 3 to 5 μ long (Heldt, 1938; Hudin 1942). In two species, Heldt even reported a slow, trembling rotation of the sperm, but this possibly have been Brownian movement.

Transverse striation of the isopod sperm tail also recalls the fine structure of the ks of *Zoothamnium,* a colonial ciliate, in which cilia of the classical construc-, with 9 + 2 fibrils, apparently undergo transition into a hollow, transversely ated tube with a periodicity of 44-47 mμ (Rouiller *et al.*, 1956). Collagen-like ils with a similar banding have rarely been found in arthropods, though there a few such records (e.g. Gray, 1959). One should not speculate further on sible homologies until the chemical nature of the sperm tails of isopods and ed crustaceans has been established.

nowledgements

he authors are grateful to Dr. W. D. Burbanck for having brought the immo-y of *Cyathura* sperm to their attention, and for providing animals of this genus. his work was supported by the National Institutes of Health under Research nt E. 1445.

RÉSUMÉ

. microscopie électronique a révélé un type unique de flagelle caudal chez les spermatozoïdes des odes *Cyathura* sp., *Idotea balthica* et *Oniscus asellus.* Ce flagelle consiste en un long cylindre ble (ou élastique), de 300-350 mμ de diamètre, transversalement strié à travers toute son seur avec une alternance régulière de bandes denses et de bandes moins denses. Il y a une partie e segmentée, mais aucune preuve d'une structure fibrillaire analogue à celle que l'on a trouvée toutes les queues de spermatozoïdes examinées jusqu'ici avec le microscope électronique. Les ications phylogénétiques de cette structure inhabituelle sont discutées.

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ARVAL VARIATION IN *PHILOCHERAS BISPINOSUS* (HAILSTONE) (DECAPODA, CRANGONIDAE)

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has long been known that typical adult specimens of *Philocheras bispinosus*
ilstone) [= *Pontophilus bispinosus* Hailstone, 1835] may be linked through
mplete series of intermediate forms to that originally described as *Cheraphilus*
'ectus by G. O. Sars (1882) (Appellöf, 1906, p. 130; Hansen, 1908, p. 47).
some areas the intermediate forms are absent and only the *bispinosus* and
'ectus forms have been found (Kemp, 1910, p. 154). Larvae have been de-
bed for the *bispinosus* form only (Sars, 1890; Lebour, 1931), and the present
er records the larval variation within the *bispinosus-neglectus* complex. The
lished information on the adults, as well as that given below for the larvae,
gests that the *bispinosus* and *neglectus* forms should be recognised as subspecies
ixley, 1940, p. 26), and nomenclature in accordance with this is adopted in
paper.

n ovigerous female of *Philocheras bispinosus neglectus*, collected just North of
Castle, Little Cumbrae Island, Firth of Clyde, released larvae in the Millport
ratory on 14 May, 1959. Several of the larvae, fed on nauplii of *Artemia,* sur-
d to the last zoeal stage (stage V) and one to the megalopa (post-larva). These
ae resembled those of *Philocheras bispinosus bispinosus* in both size and chro-
ophore pattern (Fig. 1 *a, b*), but apart from the rostrum and the pterygostomian
e, neither the carapace nor the abdominal somites bore any spines or denticles
ny stage. In all zoeal stages of *P. b. bispinosus* there are 4-6 carapace denticles
nd each pterygostomian spine and a pair of dorso-lateral spines on each of
ominal somites 3, 4 and 5 (Fig. 2 *a*).

he rostrum of the reared larvae of *P. b. neglectus*, as in other members of the
is, consists of a broad base and a sharp terminal portion. The inner ramus of
antennule was equal to or only slightly longer than the outer in all stages (Fig.
, and the antennal scale was about 4 times as long as broad in stage I, becoming
mes as long as broad by the last zoeal stage (Fig. 2 *c*). Setose exopods were

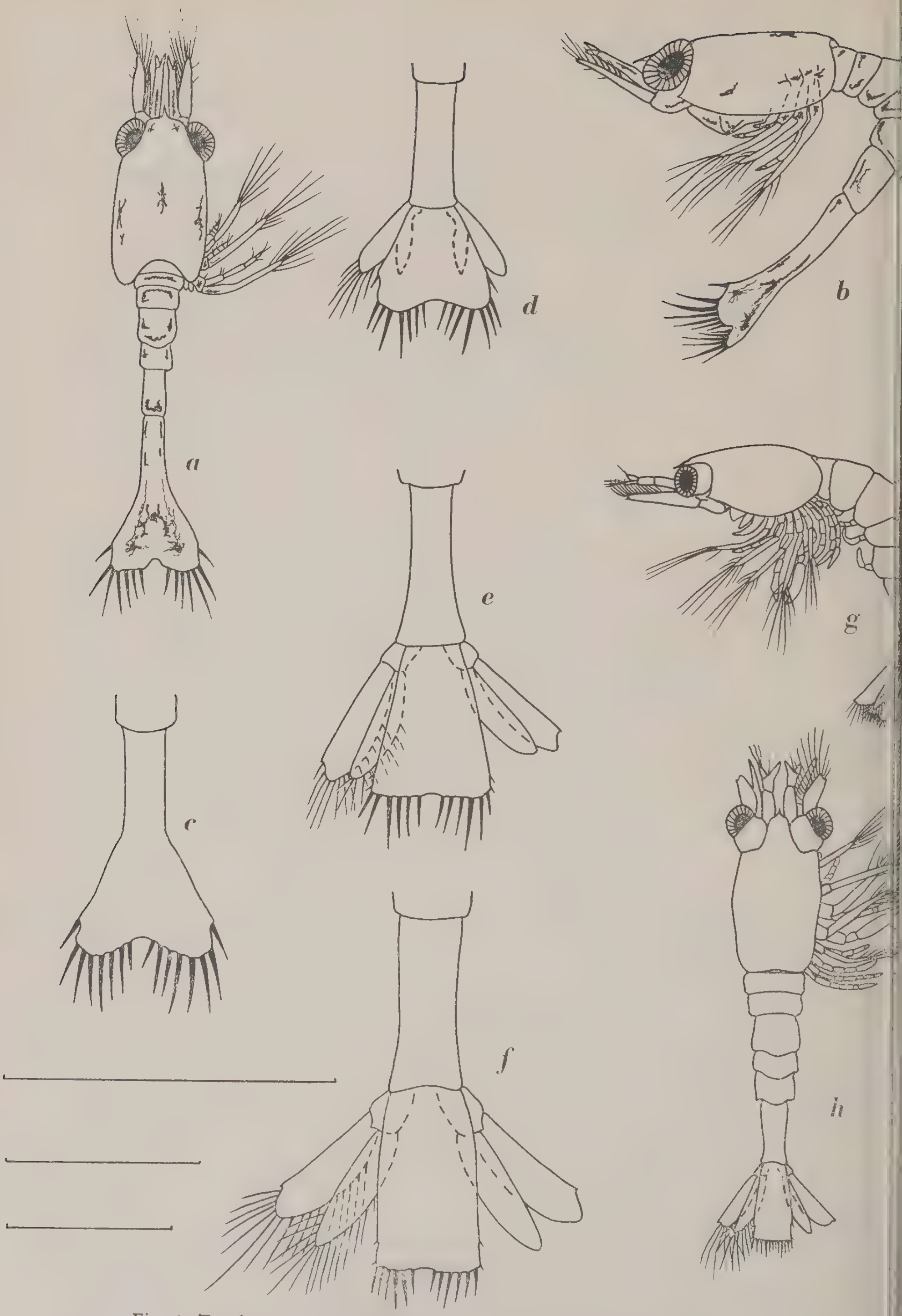
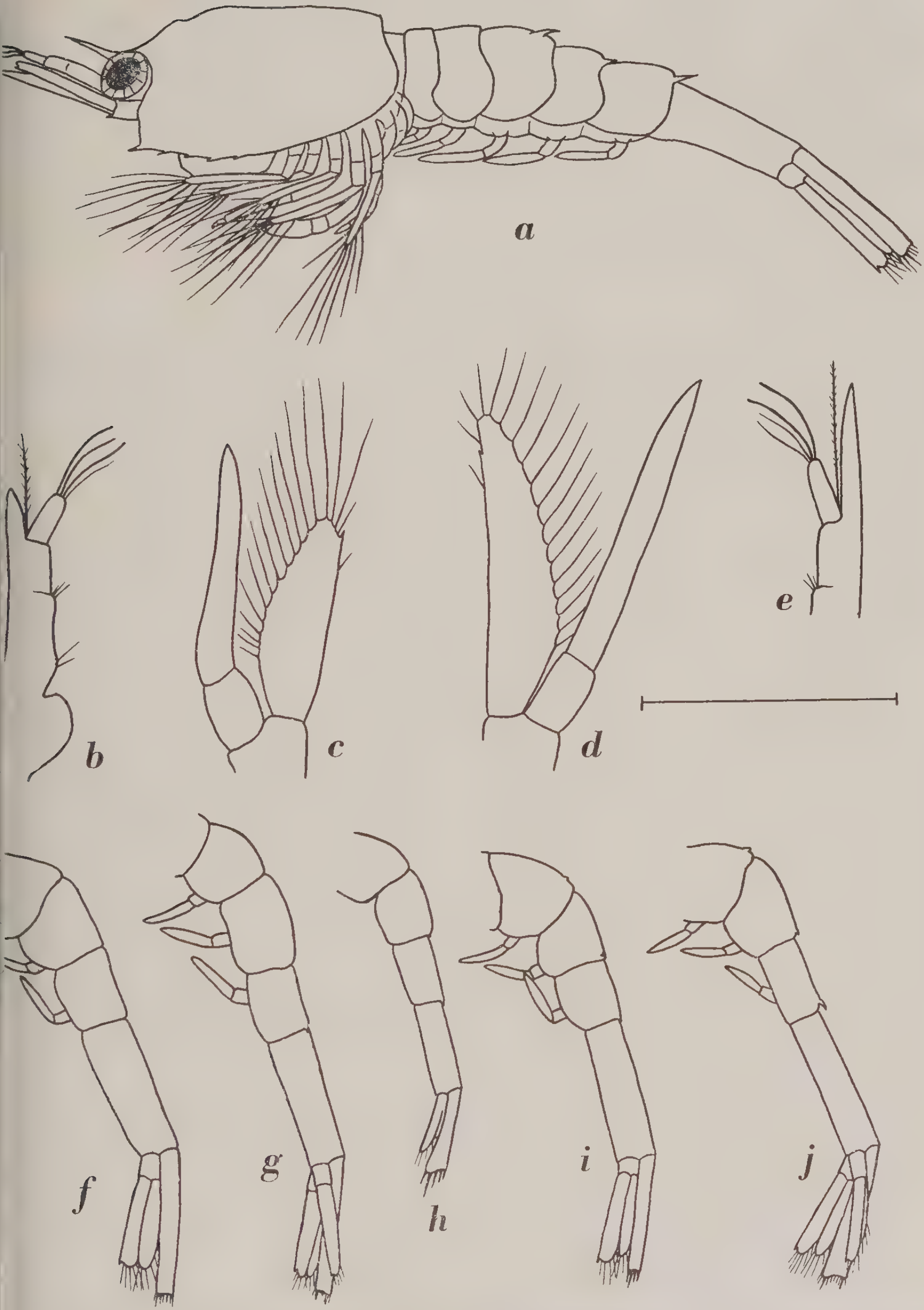


Fig. 1. Zoeal stages of *Philocheras bispinosus neglectus*, reared in the laboratory. *a*, *b*, stage I, dorsal and lateral views; *c-f*, end of abdomen, stages II-V; *g*, *h*, stage V, dorsal lateral views.

(Scales: upper = 1 mm: *a*, *b*; middle = 0.5 mm: *c-f*; lower = 1 mm: *g*, *h*).



2. *a, Philocheras bispinosus bispinosus,* Irish Sea Plankton, stage V. *b, c, P. b. neglectus,* reared
lport, stage V: *b,* antennule; *c,* antenna. *d, e, P. trispinosus,* Irish Sea Plankton, stage V: *d,*
nna; *e,* antennule. *f-j.* abdomens of larvae intermediate between *P. b. neglectus* and *P. b. bispi-*
us, Firth of Clyde plankton: *h,* stage III; others, stage V. (Scale = 1 mm for figs. *a, f-j* and 0.5 mm for *b-e*).

present on all three pairs of maxillipeds from stage I, on the 1st pair of legs f stage II, and on the 2nd pair of legs from stage IV. No exopods were develope the posterior three pairs of legs. Pleopod buds first appeared in stage IV and development of the telson in the five zoeal stages is shown in Fig. 1 (*a, c* Approximate lengths of the larvae (from tip of rostrum to posterior margin telson) were: stage I, 1.4 mm; stage II, 1.7 mm; stage III, 2.0 mm; stage 2.5 mm; stage V, 3.2 mm; megalopa, 2.8 mm.

The only larvae of *Philocheras* previously known to lack carapace denticles abdominal spines are those of *P. trispinosus* (Hailstone) (Gurney, 1903; Willi son, 1911; Lebour, 1931). These larvae are, however, nearly 50% bigger t those of *P. bispinosus neglectus,* the inner ramus of the antennule is about times as long as the outer in stage I and about twice as long in the other st (Fig. 2*e*), and the antennal scale is about 5 times as long as broad in the last z stage (Fig. 2*d*).

Five larvae, agreeing with the reared specimens of *P. b. neglectus* on all m points, including the complete absence of carapace denticles and abdominal spi have been taken in the Irish Sea in recent years, all in the months of May June. In the same area, typical larvae of *P. b. bispinosus* have occasionally b taken in May and very commonly in September and October, but no larvae in mediate between *P. b. neglectus* and *P. b. bispinosus* have been found. In the I of Clyde, too, larvae of *P. b. bispinosus* have been very common in the autu of each year, typical examples making their first appearance in early Septem Records from this area, however, differ from those from the Irish Sea in tha larvae of *P. bispinosus* (including *neglectus*) have shown at least some indica of carapace denticles or abdominal spines or both, and also that a numbe larvae intermediate between *P. b. neglectus* and *P. b. bispinosus* have been tak In 1959 about 20 such intermediate larvae were taken between late May and August. They included specimens without abdominal spines but with 2 mi antero-ventral carapace denticles on each side, several without carapace denti but with small spines on the 5th abdominal somite only, and others with 2 o small carapace denticles on each side and small abdominal spines on somite 5 o or on somites 4 and 5, or on somites 3, 4 and 5. The variations in abdom armature are shown in Fig. 2 (*f-j*). After late August, although larvae of *P* *bispinosus* were very common, only one atypical larva was encountered; this w specimen in stage IV without spines on the 4th somite, taken in late Septem Intermediate type larvae were, therefore, practically confined to the late sp and summer months. There was apparently no progressive change from the *n* *lectus* type to the *bispinosus* type during these months.

There is no direct evidence that the intermediate larvae came from, or wo have developed into, intermediate adults, but such adults do occur in the Fi of Clyde, and their connection with the intermediate larvae seems likely. In Irish Sea, neither intermediate adults nor larvae have been recorded, and o a few adults of *P. b. neglectus* have been taken.

The larval variations within *P. bispinosus* appear, on the evidence available, run closely parallel to the adult variations, and therefore to provide an example complete congruence (De Beer, 1940, p. 368). Divergence of the two sub- cies, *P. b. bispinosus* and *P. b. neglectus,* seems to have taken place without ier geographical isolation or difference in local habitat, but a large degree of ietical isolation seems to have been achieved through differences in breeding iod. Huxley (1940, p. 14) and Hogben (1940, p. 278) comment on the evo- onary importance of this form of barrier to interbreeding.

ZUSAMMENFASSUNG

ie Zoëa-Stadien von im Mai im Laboratorium erbrüteten *Philocheras bispinosus neglectus* Larven len beschrieben.

ie unterscheiden sich von *P.b. bispinosus* Larven, gleichen aber in etwa den Larven von *P. trispi-* Im Clyde-Busen scheint sich *P.b. neglectus* im Spät-Frühling fortzupflanzen, *P.b. bispinosus* gen im Herbst. Eine vollständige Larvenserie, die diese Unterarten miteinander verbindet, wurde rend des Sommers gefunden.

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GROWTH, MOLTING FREQUENCY, HEART BEAT, NUMBER OF EG AND INCUBATION TIME IN *GAMMARUS ZADDACHI* EXPOSED DIFFERENT ENVIRONMENTS

BY

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University of Toronto, Canada. [1]

The data published in this paper on *Gammarus zaddachi* Sexton, 1912 (se Spooner, 1947) are the results of investigations carried out in 1952 and 195 Kiel, North Germany. Corresponding data on *Gammarus salinus* Spooner, 19 have been published in an earlier issue of this journal (Kinne, 1960). The re is referred to that article for details on material and methods.

RESULTS

Gammarus zaddachi Sexton (sensu Spooner) is more difficult to rear ur laboratory conditions than is *G. duebeni* Lilljeborg. Up to 35 % of the fre hatched young died before attaining sexual maturity. In *G. duebeni* the mort during this period was only approximately 6 % under the same conditions.

1. GROWTH

All experiments on growth were performed on the F_1 generation of specim from the "Kleiner Kiel" (see Kinne, 1960) at water temperatures between 19 and 20.0° C, and a salinity of 10 ‰ ± 0.4 ‰. The growth rate was measu as increase in body length (straight line distance from the tip of the rostrum to base of the telson with the body straightened out). Body length was determine living specimens transferred on to a glass plate with millimeter paper attache its subsurface. Three readings were taken in each case and their results avera The age is expressed in days after hatching.

Freshly hatched *G. zaddachi* are — at 19° to 20° C and a salinity of 10 ‰ approximately 1.8 mm long. They grow at about the same rate as *G. salinus*, much faster than *G. duebeni* (fig. 1, table I). A more detailed analysis of

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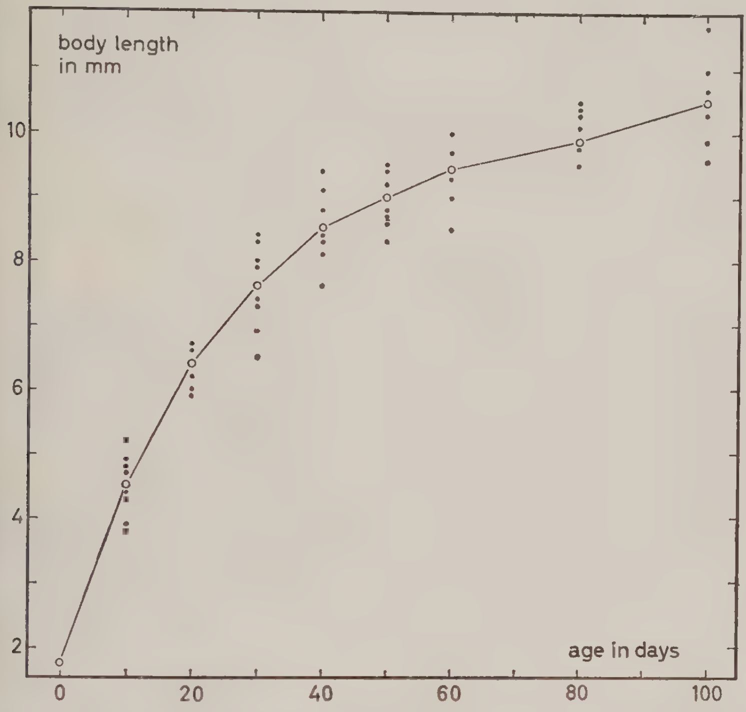
wth data seems to indicate a slightly less rapid growth in *G. zaddachi* as com-
ed with *G. salinus.*



1. Growth in *Gammarus zaddachi* females. Individual data (.) and averages (0) see also table I. The age is given in number of days after hatching. t°C: 19.0 to 20.0; $S^0/_{00}$: 10 ± 0.4.

TABLE I

wth (increase in body length) in Gammarus zaddachi *females. The body of table contains individual length-data in mm. The means are shown for each group at the bottom of the appropriate column. t°C: 19.0-20.0; $S^0/_{00}$: 10 ± 0.4.*

Age in days after hatching							
10	20	30	40	50	60	80	100
3.8	5.9	6.5	7.6	8.3	8.5	9.0	9.6
3.9	6.0	6.9	8.1	8.6	9.0	9.5	9.9
4.3	6.2	7.3	8.3	8.7	9.3	9.8	10.3
4.3	6.4	7.4	8.4	8.8	9.5	9.9	10.5
4.4	6.4	7.7	8.5	8.9	9.5	10.1	10.6
4.7	6.5	7.7	8.5	9.2	9.5	10.3	10.7
4.8	6.5	7.9	8.6	9.2	9.6	10.4	11.0
4.8	6.6	8.0	8.8	9.4	9.7	10.4	11.7
4.9	6.7	8.3	9.1	9.4	10.0	10.5	—
5.2	6.7	8.4	9.4	9.5	10.0	—	—
4.51	6.39	7.61	8.53	9.00	9.46	9.99	10.54

The minimum size for egg carrying *G. zaddachi* females is approximately 7 During June and July, however, several of the 7 to 9 mm long females were non-breeding condition carrying small oostegites without bristles. Such a breeding condition ("Ruhezeit", "close season", "resting period") is know exist in *G. duebeni* (Legeux, 1924; Kinne, 1953a, 1953c; Hynes, 1954). *G. pulex* (Heinze, 1932), and in other gammarids (Hynes, 1955, and others). physiology of the non-breeding condition is not yet completely understood. phenomenon may be related to changes in the physical environment, particul to changes in the annual temperature and light cycles.

2. MOLTING FREQUENCY

The molting dates were recorded in specimens living in constant (± 0.4 salinities of 5 ‰, 10 ‰ and 30 ‰ respectively. The temperature in the cul dishes was close to the conditions in the natural habitat: the daily means app imated those in the Kleiner Kiel (east shore), resulting in an almost iden annual temperature curve (for details see Kinne, 1960). Water temperatures in culture dishes were recorded daily at noon, and the diurnal fluctuations (maxin 0.5° C) determined using minimum-maximum thermometers. From these data daily means were calculated. Later, the daily means were averaged for the per

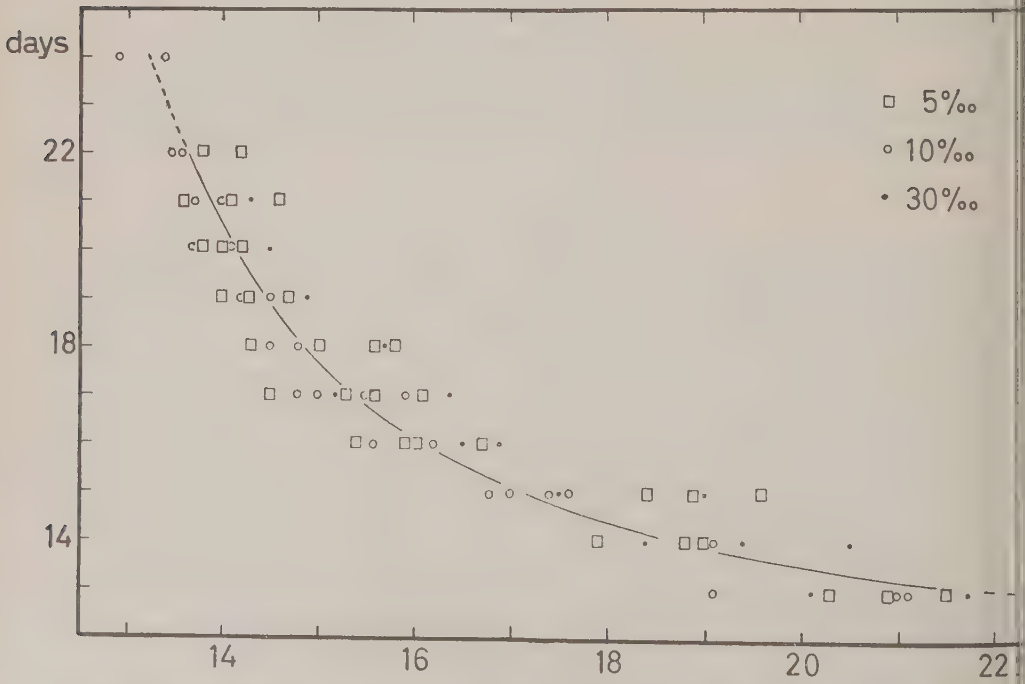


Fig. 2. Molting frequency of mature *G. zaddachi* females at different reference temperatures and different salinities. See also table II. Individual data.

ween two subsequent molts. These averages are, in the following pages, being erred to as "reference temperatures".

In general, the relation between the reference temperatures and the molting ervals is similar to that previously established for *G. salinus*. The salinity, too, ects the molting frequency in a similar way in both species. Under identical temrature and salinity conditions, *G. zaddachi* females exhibit shorter molting interls than the males. The same situation was found earlier in *G. duebeni* and *salinus*.

As in *G. duebeni* and *G. salinus*, the *G. zaddachi* females tend to progressively olong the intervals between two subsequent molts if kept without a male. The olongation of the molting intervals begins in these so-called "solo-females" ually with the third or fourth interval following the beginning of the isolation.

The relation between reference temperature and molting frequency in mature males is presented in fig. 2 and table II. No significant differences were observed specimens exposed to 5 $^0/_{00}$, 10 $^0/_{00}$ and 30 $^0/_{00}$, respectively (table II).

TABLE II

olting frequency of mature G. zaddachi *females at different temperatures and inities. Individual data. The left column gives the duration of the intervals tween two subsequent molts; the body of the table contains the corresponding reference temperatures in °C.*

Intervals in days	5$^0/_{00}$				10$^0/_{00}$				30$^0/_{00}$		
13	20.3	20.9	21.5	—	19.1	20.3	21.0	21.1	23.1	20.1	21.7
14	14.1	14.0	13.6	14.6	19.1	19.0	—	—	19.4	18.4	20.5
15	13.8	14.2	—	—	17.4	17.0	17.6	16.8	17.5	19.0	—
16	14.1	14.2	14.0	13.8	16.0	16.6	16.2	15.6	16.9	16.5	—
17	14.0	14.7	14.3	14.3	15.0	15.5	14.8	15.9	15.2	16.4	—
18	15.6	15.8	15.0	14.3	14.8	14.5	15.0	—	15.7	—	—
19	14.5	15.6	16.1	15.3	14.2	14.3	14.5	14.5	14.9	—	—
20	16.0	15.4	15.9	16.7	14.0	13.7	14.0	14.1	14.5	14.1	—
21	18.9	18.4	18.9	19.6	14.0	13.7	13.7	—	14.0	14.3	—
22	17.9	18.8	18.9	19.0	13.6	13.5	—	—	—	—	—

3. RATE OF HEART BEAT

The same method was applied as for *G. duebeni* (Kinne, 1952b, p. 140). All ecimens were tested under the given conditions, i.e., in the same water and at same temperature (max. deviation ± 0.2°C) as in their culture dishes.

The effect of the temperature on the rate of heart beat is shown in fig. 3 and le III. The activity of the heart is similarily affected as in *G. salinus*; both ecies, however, differ in this respect considerably from *G. duebeni*.

An analysis of the data obtained does not produce evidence for major differences tween mature males (17 to 21 mm length) and mature females (14 to 16 mm). oreover, within these size groups no relationship between body length and rate

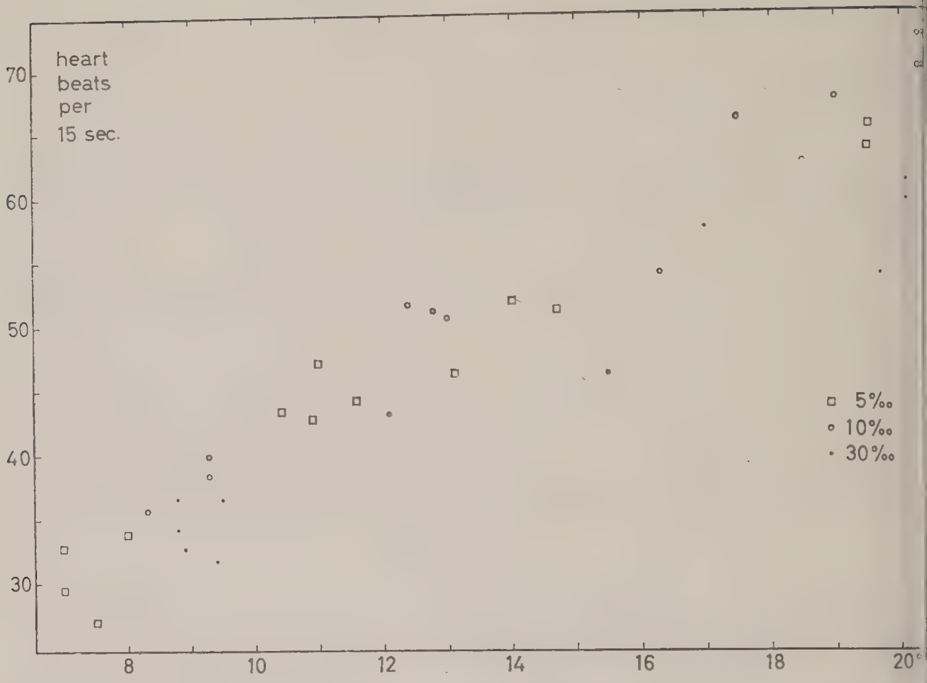


Fig. 3. Rate of heart beat in mature *G. zaddachi* males exposed to different temperatures different salinity levels. See also table III. Averages of 10 counts in each case.

Table III

Rate of heart beat in mature G. zaddachi *males at different temperatures salinities. Given are the number of heart contractions per 15 seconds and lengths of the specimens to the nearest 0.5 mm. Each heart beat value repres the average of 10 counts.*

		7.0°	7.0°	7.5°	8.0°	10.4°	10.9°	11.0°	11.6°	13.1°	14.0°	14.7°	19.5°	19
$5^0/_{00}$	heart beats	29.3	32.9	26.7	33.8	43.3	42.5	47.2	44.0	46.2	51.7	51.0	65.2	6
	body length (mm)	18.0	19.5	20.5	18.0	20.5	17.5	20.0	17.5	18.0	19.5	20.5	19.5	19
		8.3°	9.3°	9.3°	12.4°	12.8°	13.0°	16.3°	17.5°	18.5°	19.0°	20.3°	20.3°C	
$10^0/_{00}$	heart beats	35.6	38.3	40.0	51.7	51.1	50.5	53.9	66.0	62.5	67.4	69.8	72.3	
	body length (mm)	17.5	19.5	17.0	17.0	18.5	18.0	17.0	17.5	18.0	18.5	17.0	20.5	
		8.8°	8.8°	8.9°	9.4°	9.5°	12.1°	15.5°	17.0°	19.7°	20.1°	20.1°C		
$30^0/_{00}$	heart beats	34.1	36.6	32.6	31.7	36.5	43.0	46.3	57.5	53.9	59.7	61.0		
	body length (mm)	19.5	17.5	21.0	17.0	21.0	18.5	20.0	19.5	17.5	17.5	17.0		

heart beat could be established. Such a relationship does, however, exist over a ler range of body length: The number of heart beats per 15 seconds is definitely ater in immature specimens. This could be shown in experiments using 5 to nm long individuals of *G. zaddachi* and *G. salinus,* and has also been reported lier in *G. duebeni* (Kinne, 1952b). The rate of heart beat depends, moreover, the physiological condition of the shrimps: it is usually somewhat irregular und the molting dates and under stress, e.g. sudden changes in salinity or perature.

No significant differences were found in $5^0/_{00}$ or $10^0/_{00}$. Possibly there is a ht retardation in $30^0/_{00}$; the number of values available for this salinity level nsufficient for a detailed analysis.

4. NUMBER OF MARSUPIUM EGGS

The egg counts included freshly laid eggs and all subsequent developmental es previous to the formation of pigmented eye spots in the embryo. Eggs in a re advanced stage of development or broods in the process of hatching were luded.

n rearing experiments, the capacity of egg production was tested in two groups females: one group was exposed to temperatures between 18° and 20°C and second group was exposed to temperatures between 14° and 16°C. The salinity 10 ± $0.4^0/_{00}$ in both cases. Table IV presents individual counts in the 18°. C group and the corresponding average values. Table V gives the average data the 14°-16°C females. The body length of the females was determined to the rest millimeter in all cases.

he differences between the two series of females are highly significant in all groups, the probability of exceeding the observed value of *t* being much ller than .001: the females of all size groups carry considerably more eggs at lower temperature, i.e., 14°-16° C. The egg numbers of both groups compare l with those previously obtained from samples of the Kleiner Kiel population lf (Kinne, 1952a, p. 201), caught at corresponding temperatures.

n $5^0/_{00}$ the number of eggs per female seems to be similar to the figures found the $10^0/_{00}$ level (unfortunately, part of the notes concerning the $5^0/_{00}$ group e lost). In $30^0/_{00}$, considerably fewer eggs were produced and no young were rved to hatch. Young and mature specimens showed a markedly higher mor- y in $30^0/_{00}$ than in $5^0/_{00}$ or in $10^0/_{00}$. It is quite evident that a constant salinity $0^0/_{00}$ represents a great physiological stress to *G. zaddachi.*

he number of eggs per female increases with the length of the mother animal. s finding is in agreement with observations on other amphipods (e.g. Cheng, 2; Berg, 1948; Clemens, 1950; Kinne, 1952a, 1953d, 1960; Hynes, 1954, 5) and with reports on various other Crustacea. In an attempt to specify the tion between female size and egg number, Forster (1951) working with *nder squilla* and *L. serratus* suggested that the number of eggs might be a linear

function of the volume of the female. While Forster did not examine this th
in detail, Jensen (1958), who arrived independently at the same assumption, d
onstrated in a careful analysis that such a relation does exist in several M

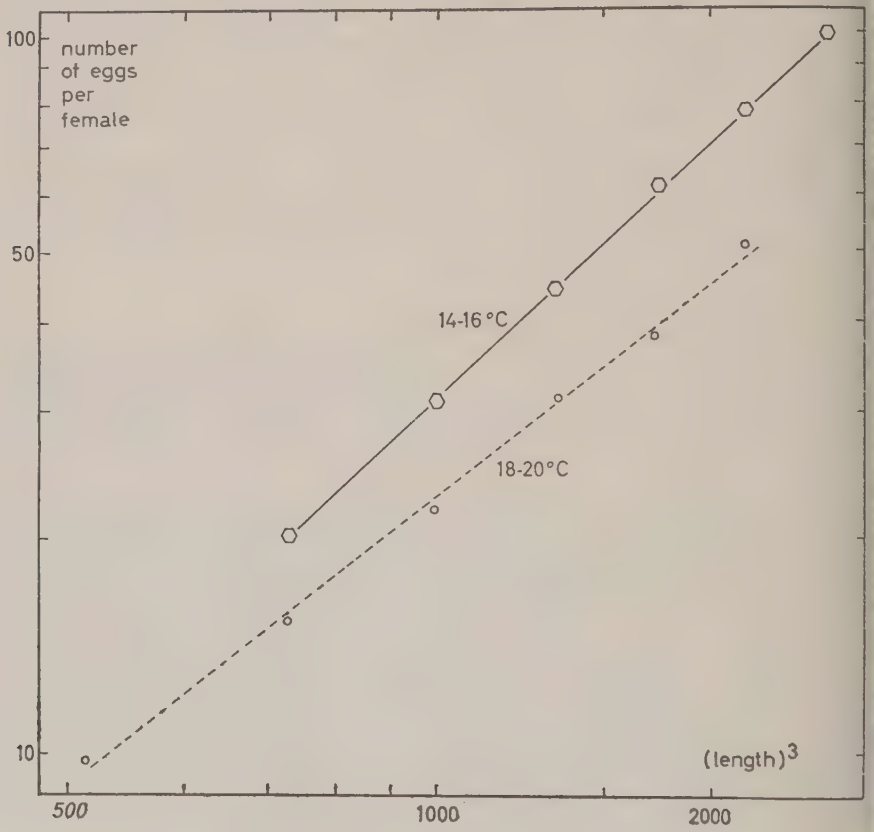


Fig. 4. Relation between body size (cubed length) and number of marsupium eggs in *G. zad*
females exposed to two different temperature levels. $S^0/_{00}$: 10 ± 0.4. See also tables IV an
Averages of 15 to 20 individuals in each case. Logarithmic coordinates.

costraca. Jensen comes to the conclusion "that the quantity of eggs produced
female as regards the *absolute number* is determined by the external factors, w
as the *relative number* depends on the volume of the female in such a way
the number of eggs becomes a linear function of the volume of the female" (p
This conclusion is confirmed by the results of my work on *G. zaddachi.* I
plot the average egg number per female (tables IV and V) against the c
female length (volume), the relation of egg number to female volume is expre
best as a straight line. This holds for the group exposed to 18°-20°C as we
for the group exposed to 14°-16°C. On logarithmic coordinates (fig. 4), the
from tables IV and V indicate that the egg number is not only greater at 14°-1
than at 18°-20°C, but that it also increases faster with increasing size of the mo
animal.

TABLE IV

tion between the number of marsupium eggs (body of the table) and the th of the mother animal at 18° to 20° C and 10 ± 0.4 $^0/_{00}$ S. Individual data, and average values (bottom).

	Length of mother animal					
nm	9 mm		10 mm	11 mm	12 mm	13 mm
14	15	12	16	39	46	48
12	19	14	22	27	18	54
14	14	13	17	35	14	40
10	12	17	21	40	40	57
10	19	22	40	42	40	53
10	20	20	18	36	29	50
6	15	13	20	11	51	60
10	12	16	22	27	39	51
8	14	21	17	28	37	52
9	20	18	23	32	40	36
10	16	15	20	26	39	64
13	21	17	17	38	19	60
6	13	15	23	20	41	52
14	15	14	21	42	50	43
10	16	10	19	31	28	62
8	16	10	24	31	50	70
7	11	12	19	30	43	30
5	17	12	22	32	41	39
6	14	11	31	28	53	50
10	19	13	24	34	40	51
.8	15.3		21.8	31.5	37.9	51.1

TABLE V

tion between number of marsupium eggs and length of mother animal at 14° 5° C and 10 ± 0.4$^0/_{00}$ S. Average data, based on 20 to 22 counts in each case. (f standard deviation, F standard error of individual counts).

9 mm			10 mm			11 mm		
	f	*F*		*f*	*F*		*f*	*F*
	4.6	*1.0*	31.0	*7.3*	*1.6*	43.9	*10.9*	*2.4*
12 mm			**13 mm**			**14 mm**		
	f	*F*		*f*	*F*		*f*	*F*
	10.0	*2.2*	77.2	*11.3*	*2.5*	101.3	*11.5*	*2.5*

linear relationship between egg number and female volume may not exist if old females are included. Results on *G. duebeni* (Kinne, 1952a, 1953a; Hynes,) demonstrate, that the number of eggs may decrease in "senile" females, n females reaching their maximum physiological age. Such females tend to produce fewer eggs, especially in the oviposition preceeding death. I have fo the same to be true in *G. salinus* and *G. zaddachi*. Furthermore, in females *G. duebeni*, *G. salinus* and *G. zaddachi* a normal number of eggs is produced o in the presence of a male — more precisely: following a proper transfer of spe

5. INCUBATION TIME

Only a few data on incubation time (days between oviposition and hatchi are available. These data demonstrate that the temperature effect on the rate embryonic development is quite similar to that in *G. salinus* (Kinne, 1960). greater number of measurements may lead to the discovery of differences betw *G. zaddachi* and *G. salinus*. However, such differences, if they occur, will small — much smaller than those between *G. salinus* and *G. duebeni*.

No broods were observed to hatch in $30^0/_{00}$. The few data available mak impossible to evaluate the effect of the salinity factor on the embryonic devel ment. It is quite clear, however, that $30^0/_{00}$ offers less favourable conditions th does the $5^0/_{00}$ or the $10^0/_{00}$ salinity level.

SUMMARY AND CONCLUSIONS

Gammarus zaddachi from the Kleiner Kiel, Kiel, North Germany, were exp to different temperature and salinity conditions in the laboratory and the rate some life processes measured. All tests were performed under standard condit (food, light, amount of water per individual, quality of water). The rates growth, molting, heart beat, egg production and embryonic development pro to be similar in the same environment to those of the previously tested *G. sal.* (Kinne, 1960) from the same habitat. *G. zaddachi* and *G. salinus*, however, di considerably with respect to these rate functions from a third *Gammarus* spe of the Kleiner Kiel, namely *G. duebeni*. The latter exhibits much slower r under the same conditions (Kinne, 1952b; 1953a, b).

The intervals between subsequent molts are longer in *G. zaddachi* males t in females. No significant differences were observed in specimens exposed to salinity levels $5^0/_{00}$, $10^0/_{00}$ and $30^0/_{00}$, respectively. Females kept without m tend to prolong progressively the molting intervals, beginning with the thir fourth interval after isolation.

No relationship between body length and rate of heart beat could be establi in 17 to 21 mm long males or in 14 to 16 mm long females. Such a relations does, however, exist over a wider range of body length: the rate of heart cont tions is definitely higher in immature specimens of a length of 5 to 6 mm. significant differences of rates of heart beat in mature specimens were obser in $5^0/_{00}$ or $10^0/_{00}$.

The number of marsupium eggs per female of a given length depends on temperature, being higher at 14° to 16°C than at 18° to 20°C, and on the salin There exists a linear relationship between the number of eggs and the volu

bed length) of the mother animal, except in senile females. In the absence
male, there is a tendency to reduce progressively the number of eggs laid.
ormal number of eggs is usually deposited only subsequent to a transfer of
m.

long with the functional similarity between *G. zaddachi* and *G. salinus* there
s a striking structural similarity (Spooner, 1947; Segerstråle, 1947; Kinne,
4, etc.). The information available suggests that *G. zaddachi* and *G. salinus*
esent two relatively young species which have only recently become genetically
pendent from each other (see also Spooner, 1947, 1951; and Kinne, 1954).
differences between these two species become apparent in terms of their distri-
on, ecology and interspecific sterility (Spooner, 1947; Segerstråle, 1947; Steen,
; Kinne, 1954; Forsman, 1956) rather than in terms of the rate functions or
hological expressions studied. The physiological data available at this time are
sufficient for a detailed analysis. More elaborate experiments on the physio-
al potentialities of *G. zaddachi* and *G. salinus* may lead to the discovery of
ate differences and to a better understanding of their ecology and evolution.

ZUSAMMENFASSUNG UND SCHLUSSFOLGERUNGEN

mmarus zaddachi vom Kleinen Kiel, Kiel, Norddeutschland, wurde im Laboratorium verschie-
Temperatur- und Salzgehaltsbedingungen ausgesetzt und die Intensität einiger Lebensprozesse
elt. Alle Versuche wurden unter Standardbedingungen (Nahrung, Licht, Wassermenge pro
duum, Wasserqualität) durchgeführt. Die Intensität von Wachstum, Häutungsfolge, Herz-
nz, Eiproduktion und Embryonalentwicklung ist unter gleichen Umweltbedingungen ähnlich der
dem vorher untersuchten *G. salinus* (Kinne, 1960) vom gleichen Biotop. *G. zaddachi* und
inus unterscheiden sich jedoch hinsichtlich der Intensität dieser Lebensprozesse eindeutig von
dritten *Gammarus* Art des Kleinen Kiels, nämlich von *G. duebeni*. Letzterer zeigt unter gleichen
gungen viel geringere Intensitäten (Kinne, 1952 b; 1953 a, b).

Intervalle zwischen zwei aufeinanderfolgenden Häutungen sind bei den *G. zaddachi* Männchen
als bei den Weibchen. In den Salzgehaltsstufen 5 $^{0}/_{00}$, 10 $^{0}/_{00}$ und 30 $^{0}/_{00}$ wurden keine ein-
en Unterschiede festgestellt. Ohne Männchen gehaltene Weibchen zeigen eine Tendenz zur Ver-
ung der Intervalle, und zwar beginnend mit dem dritten oder vierten Intervall nach erfolgter
on.

17-21 mm langen Männchen und 14-16 mm langen Weibchen konnte keine Beziehung zwischen
rlänge und Herzfrequenz nachgewiesen werden. Eine derartige Beziehung besteht jedoch bei
ren Längenunterschieden: Die Herzfrequenz ist deutlich höher bei 5-6 mm langen Jungtieren.
Salzgehaltsstufen 5 $^{0}/_{00}$ und 10 $^{0}/_{00}$ wurden keine signifikanten Unterschiede in der Herzfre-
adulter Tiere festgestellt.

Anzahl der Marsupialeier pro Weibchen einer gegebenen Länge hängt ab von der Temperatur
6° C $>$ 18°-20° C) und vom Salzgehalt. Es besteht eine lineare Beziehung zwischen der Eizahl
em Volumen (Länge ^{3}) des Muttertieres (Ausnahme: senile Weibchen). In Abwesen-
ines Männchens wird die Anzahl der abgelegten Eier in zunehmendem Mass reduziert. Eine
le Eizahl wird gewöhnlich nur deponiert im Anschluss an eine Spermaübertragung.

en der funktionellen Ähnlichkeit von *G. zaddachi* und *G. salinus* besteht eine bemerkenswerte
irelle Ähnlichkeit zwischen diesen beiden Arten (Spooner, 1947; Segerstråle, 1947; Kinne,
etc.). Die vorliegenden Informationen drängen zu der Annahme, dass *G. zaddachi* und *G. sali-*
vei relativ junge Arten repräsentieren, die erst kürzlich ihre genetische Selbständigkeit erlangt
(siehe auch Spooner, 1947, 1951; und Kinne, 1954). Die Unterschiede zwischen diesen beiden
kommen gegenwärtig vornehmlich zum Ausdruck in deren Verbreitung, Ökologie und inter-
schen Sterilität (Spooner, 1947; Segerstråle, 1947; Steen, 1951; Kinne, 1954; Forsman, 1956).
ings sind die zur Verfügung stehenden Daten unzureichend für eine ins einzelne gehende
e. Ein eingehenderes experimentelles Studium der physiologischen Potenzen von *G. zaddachi*

und *G. salinus* wird möglicherweise zur Aufdeckung delikater Unterschiede führen und zu ei
besseren Verständnis der Ökologie und Evolution dieser beiden Arten.

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THE USE OF CETYL ALCOHOL IN THE REARING OF THE RHIZOCEPHALAN LARVAE [1])

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ttempts to rear the nauplius larvae of the Rhizocephala under laboratory con-
ons have been repeated by many workers, but have met with limited success.
age (1884) who first succeeded in rearing the nauplius of *Sacculina* to the cypris
e gave a description of the method by which he obtained the cyprids. He stated
it was necessary to select adult Sacculinae in which the nauplii were ready to be
hed, to wait for the emission of healthy nauplii, and then keep them in a vessel
ater without current or aeration. Following Delage's direction, Smith (1907)
eeded in rearing the nauplii of *Sacculina* to cyprids. He warned that the sea
r to be used must be of great purity, since the multiplication of Infusoria and
ne in water is highly injurious to the nauplii. Recently, Veillet (1943, 1947,
2) succeeded in rearing the nauplii of *Lernaeodiscus, Septosaccus*, and *Gemmo-*
us, and gave detailed instructions for their cultivation (Veillet, 1951). He sug-
ed that success depends upon obtaining a normal emission of healthy larvae
h the mantle cavity of the parasites and keeping them in clean sea water from
open sea.

earing the instructions of the previous workers in mind, the author attempted
ar the nauplius larvae of *Peltogaster* and *Peltogasterella*, but with little success.
newly hatched nauplii, which swam very actively, quickly rose to the surface
he water and within a few hours many of them stuck to it. This adhesion to the
r surface was fatal and so numerous larvae, sometimes practically all of them,
before reaching the cypris stage. Even if some of the larvae successfully trans-
ned into cyprids, all of these stuck to the water surface and perished sooner or
. Attempts were therefore made to prevent the adhesion of the larvae to the
r surface. When the water surface was coated with thin films of various oils
getable, animal, and mineral) or liquid paraffin, the larvae did not adhere to
urface, but these substances were found to be harmful to the larvae. The addi-
of a small quantity of detergents (e.g., Monogen and Raipon) to sea water was
tive in preventing the adhesion of the larvae to the water surface, but these

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ro, Japan.

substances, too, were toxic to the larvae. After various other attempts the aut found that the powder of cetyl alcohol floated onto the water surface could eff tively prevent the adhesion of the larvae without injuring them appreciably. So alcohols closely related to cetyl alcohol, such as n-decyl alcohol, dodecyl alcol and n-tetradecyl alcohol, were also tested, but were found to be more or less ha ful to the larvae.

> Cetyl alcohol ($C_{16}H_{33}OH$) is one of the saturated high alcohols which extracted from spermaceti. At room temperature it is solid (m.p. ca. 50° and is scarcely soluble in water. Its specific gravity is less than that of wa When the powder of cetyl alcohol was put on the water, it spread over a coated the surface. The thin film of cetyl alcohol, thus formed, was effective preventing the adhesion of the larvae to the water surface.

The method by which the author has succeeded in rearing the nauplii of *Pe* *gaster* and *Peltogasterella* is summarized below. (1) The newly hatched nau were collected with a large bore pipette and carefully transferred into glass ves containing freshly filtered sea water. The vessels used had diameters of 5 to 15 and depths of 10 to 20 cm. It was important to avoid overcrowding of the lar (2) Soon after the larvae were placed in the vessel, the surface of the water coated with cetyl alcohol. This was done simply by putting a small quantity of p dered cetyl alcohol upon the water. Provided the water surface is clean, the pow spreads at once all over the surface. (3) The vessel was covered with a glass pl Sea water in the vessel was changed at intervals of one or two days. The water u was brought every day from the open sea and filtered through fine filter pa immediately before using. (4) The cetyl alcohol coating the water surface renewed once or twice per week. The cast-off shells of the larvae, together w unhealthy and dead larvae, were carefully discarded as frequently as possible.

Under favourable conditions, practically all the nauplius larvae transform themselves into cyprids within several days, and the latter survived for more th four days. The mortality of the larvae was usually very low. Figures 1 and 2 sh photomicrographs of the successfully reared larvae of *Peltogasterella gra* (= *Peltogasterella socialis*) and of *Peltogaster paguri*.

The larvae of some other parasitic crustaceans, such as the epicaridian larva *Bopyrus*, are known to have a strong tendency to adhere to the surface of sea wa The author has found that cetyl alcohol can effectively be used in preventing adhesion of these larvae, just as in the case of the rhizocephalan larvae.

ZUSAMMENFASSUNG

Die Zucht von Rhizocephala-Larven unter Laboratoriumsbedingungen ist ziemlich schwierig die Larven innerhalb kurzer Zeit an der Seewasseroberfläche anhaften und früher oder späte grundegehen. Dieses Anhaften kann — ohne merkbaren Schaden für die Larven — vermieden we durch an der Wasseroberfläche schwimmendes Cetylalkoholpulver. Die Larven einiger anderer C taceen, wie z.B. die Epicarida-Larven von *Bopyrus* haben ebenfalls eine starke Tendenz der wasseroberfläche anzuhaften. Auch in diesen Fällen kann Cetylalkohol mit Erfolg angewandt wer

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NOTES SUR LA FAMILLE DES LAMIPPIDAE, 2e PARTIE 1)

PAR

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3. ETUDE DE L'ESPÈCE TYPE DU GENRE *LAMIPELLA, L. FAUREI* BOULIGAND ET DELAMARE DEBOUTTEVILLE, 1959.

Description

Matériel étudié représenté sur les fig. 7 et 8: Spécimen A d'après lequ j'ai étudié: *h, n, f,* et les papilles; spécimen B: les papilles; C: Δ, et les papille D: *a1* et *p2*; E: *a2* et *p1*; F: *v*; G: *sp.*

Le nombre de spécimens recueillis étant encore faible, je remarque entre différents individus certaines variations dans le nombre des papilles ou la taille griffes, mais je ne dispose pas encore d'un nombre suffisant de mesures pour av des résultats statistiques valables.

Hôte. Ces formes ont été rencontrées chez *Alcyonium palmatum* Pallas, *Pa rythropodium coralloides* (Pallas) et *Eunicella verrucosa* (Pallas); récemment, j trouvé des formes très semblables dans les *Rolandia coralloides* Lac.-Duth.

Dimensions. Longueur moyenne 1,2 mm; largeur moyenne 0,5 mm.

Coloration. La couleur est variable suivant l'hôte et il y a peu de variati entre plusieurs échantillons issus d'une même espèce d'Octocoralliaire; les spé mens recueillis sur les Alcyons sont beige clair; ceux parasitant les *Parerythropodi* et les *Rolandia* ont une teinte verdâtre; ceux des gorgones de Banyuls sont jau citron clair. Dans tous les cas, l'avant du corps reste translucide et peu coloré.

Forme et Mouvements. Le corps peut être divisé en une région ant rieure subcylindrique portant *a1, a2, B, p1* et *p2* et une région postérieure en form d'ellipsoïde de révolution allongé, trois fois plus longue et large que la par antérieure, qui est inclinée au repos de 30° sur l'axe de la partie renflée. Il n'y pas de péristaltisme marqué, mais on peut noter quelques constrictions du cor l'animal progresse par saccades en s'accrochant avec ses *a2, p1* et *p2*.

Tégument. La région postérieure est couverte de papilles (fig. 7, h) disp sées en trois rangées antérieures *a, b* et *c*; on trouve parfois deux papilles à niveau *d* qui est celui des vulves ovigères. Entre les vulves et la furca, il y encore deux rangées de papilles. A chaque rangée, nous pouvons faire correspond un certain nombre de papilles et établir une formule papillaire pour chaque sp

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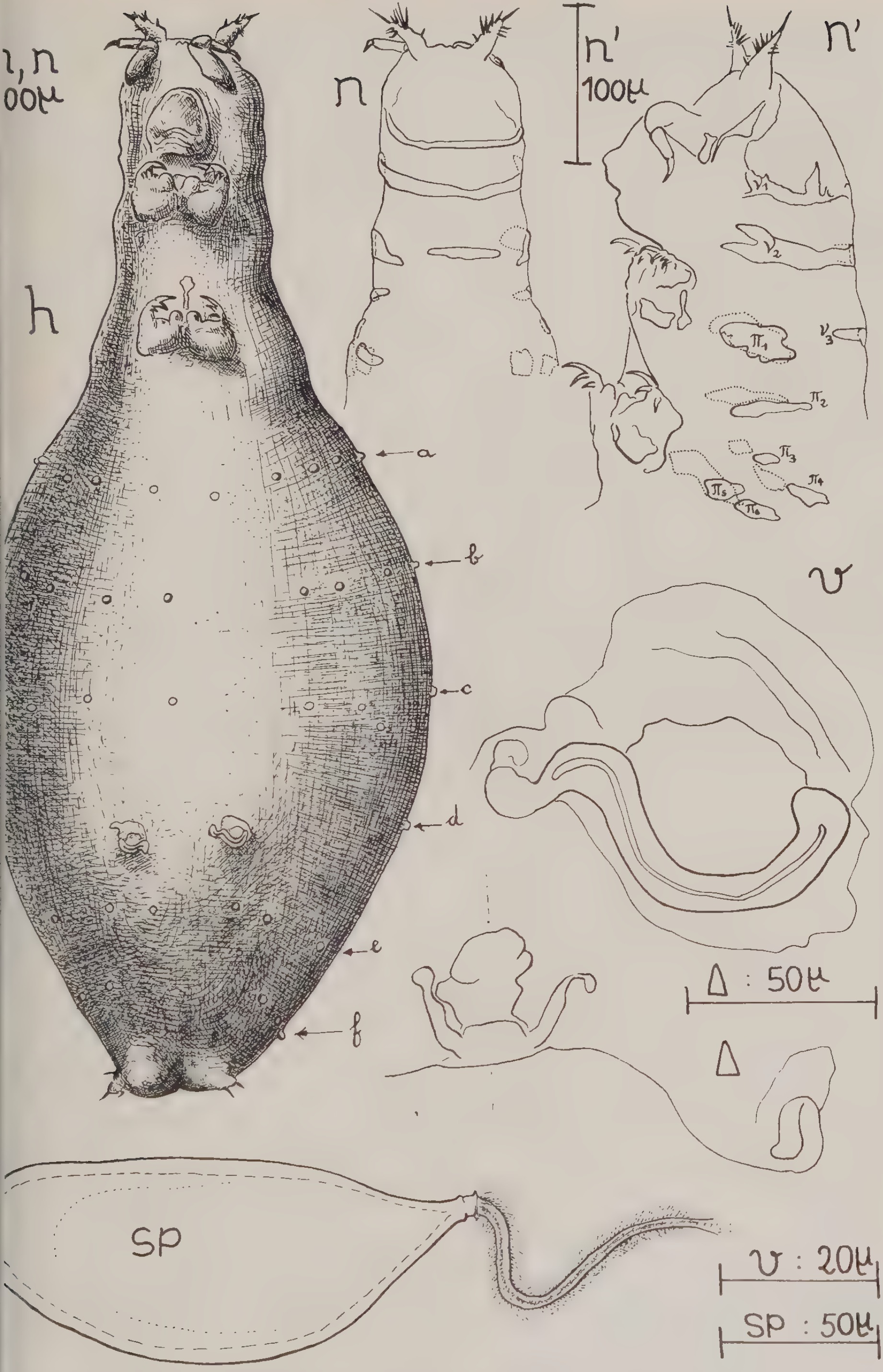
1) Première partie, voir: Crustaceana, **1** (3): 258-278.


ı, n
00μ
h
a
b
c
d
e
f
n
n'
100μ
n'
ν_1
ν_2
ν_3
π_1
π_2
π_3
π_4
π_5
π_6
v
Δ : 50μ
Δ
SP
v : 20μ
SP : 50μ

7. *Lamippella faurei* B. et D. — *h*: habitus femelle; *n* et *n'*: vues dorsale et latérale des sclérifi-
ons céphaliques; *v*: vulves ovigères; Δ: fente de libération des spermatophores; *sp*: spermatophore.

cimen. Trois exemples chez les individus issus d'un même Alcyon et cinq exem de même sexe provenant d'une *Rolandia* montrent la variabilité de cette form

Hôte: *Alcyonium*	*a*	*b*	*c*	*d*	*e*
premier spécimen ♀	16	18	15	2	8
deuxième spécimen ♂	10	14	9	2	2
troisième ,, ♂	12	14	11	2	2
Hôte: *Rolandia*					
premier spécimen ♂	12	9	4	0	3
deuxième ,, juvénile	8	6	5	0	4
troisième ,, ♂	9	7	6	0	2
quatrième ,, ♂	7	7	8	1	4
cinquième ,, ♂	11	10	9	1	5

Sur le spécimen A représenté (fig. 7, *h*), on observe une papille proche d' autre papille de la rangée *c*, mais à un niveau légèrement inférieur; de telles a malies, fréquentes, montrent que la disposition des papilles n'est pas encore b fixée; l'étude de celles-ci à la microscopie en contraste de phase révèle qu'elles s perforées d'une multitude de trous à leur sommet; en outre, les papilles d'une m rangée sont séparées par de minuscules papilles très nombreuses, sans disposi précise et qui pourraient être des granulations.

Tête (fig. 7, *n, n'*). — Un léger rétrécissement appuyé par l'épaississen *v 2* sépare la tête du tronc portant *p1* et *p2*; il n'y a pas d'oeil nauplien visible.

Appendices

Antennules (fig. 8 *a1*). — On reconnait bien les épaississements *1a1* ori dorsalement, *2a1* antérieur, *3a1* dorsal et *4a1* postérieur; *2a1* est le seul épai sement qui possède une soie lui étant nettement attachée; parmi les autres s 7 sont antérieures et 3 postérieures; il n'y a pas de soies ventrales (*s4a1* de *E. cyonium rubicundum* manque). On reconnait bien les soies terminales et pré minales *sθ* et *sσ*; *a1* est de forme trapue, composée d'un premier cylindre sclér par *1a1* et dont l'axe est dirigé vers l'avant de l'animal, puis d'un deuxième cylin portant *2a1*, *3a1* et *4a1* dont l'axe fait un angle droit avec le précédent et est di vers l'extérieur; une partie conique plus étroite porte les dernières soies.

Antennes (fig. 8, *a2*). — Les antennes sont également trapues et je retro *0a2*, *1a2*, *2a2*, *3a2*, *4a2* et *5a2*, mais *2a2* est très réduit et cette antenne a un as triarticulé. On distingue les articulations *c* (*α*, *0a2*), *c1* (*0, 1*), *c2* (*0, 1*), *c* (*1*. par condyles, puis l'articulation par arête *a* (*2, 3*) et enfin *c* (*3, 4*); nous ret vons les épaississements *a* et *b* entre *3a2* et *4a2*. La description de *a2* montre parfaite identité des segments et des articulations de *a2* dans les deux forn décrites jusqu'à présent.

Les pattes (fig. 8, *p1, p2*). Les pattes *p1* et *p2* sont légèrement plus trap que celles de *E. rubicundum*; on retrouve sur *p1* *1gf* très forte et *2gf* plus pe nie d'une soie latérale; il n'y a pas de soies attachées à *e* ou *f*. On trouve en re *3gf* sans homologue chez *E. rubicundum*; la plus petite des griffes *ge* porte soie latérale; sur *p2*, *1gf* très grande possède une soie latérale ainsi que *2gf* s petite; *3gf* manque et *ge* est munie d'une soie latérale. L'insertion de cette nière griffe n'est pas nette.

A propos de ces pattes, on peut faire les remarques suivantes:

1°. $\beta p2$ existe et non $\beta p1$. Chez *E. rubicundum*, $\beta p1$ et $\beta p2$ existent tous deux.

2°. Toutes les articulations de *p1* et *p2* de *E. rubicundum* se retrouvent, mai semble ici que *c*(*i*, *a*) soit remplacé par une arête articulaire *a*(*i*, *a*); d'autre t, β introduit l'articulation *a*(β, *e*) chez *p2* seulement.

3°. Les pattes *p1* et *p2* sont représentées sur les dessins à la même échelle et des tailles bien différentes; sur un même individu, *p1* et *p2* sont de même ndeur; *p1* appartient ici à un stade plus jeune que *p2*.

Le complexe buccal (*b*). D'une structure très compliquée, il semble d'une conuction semblable à celui de *E. rubicundum*.

Les spermatophores (fig. 7, *sp*). Ils sont plus trapus que ceux de *E. rubicundum* j'ai pu extraire plusieurs d'entre eux des mâles vivants; le long canalicule, par les spermatozoïdes s'écouleront dans le réceptacle séminal, est hérissé de strucres plus ou moins barbelées inclinées à 45° dans le sens de l'écoulement.

La fente de libération des spermatophores (Δ) et les vulves (*v*) (fig. 7). Ces fices génitaux semblables à ceux de *E. rubicundum* sont plus épais dans leur érification.

La furca (fig. 8, *f*), très simplifiée, est formée de deux mamelons hémisphéries, portant chacun une soie majeure montée sur une petite masse basale et deux es mineures latérales.

Épaississements chitineux nucaux (fig. 7, *n*, *n'*). — Nous retrouvons *ν1* et *ν2* nplètement séparés. Postérieurement à *ν2*, il y a *ν3* sans homologue chez *E. vicundum*; *ν3* est au niveau de *p1*. Ces épaississements sont allongés dans le sens nsversal.

Épaississements chitineux céphaliques latéraux. — On retrouve α entre *a1* et *a2*. λ est absent.

Épaississements chitineux latéraux aux pattes. — Un fort épaississement subellipue $\pi 1$ se dessine latéralement à *p1* (fig. 7, *n'*); au niveau de *p2*, on trouve cinq ississements notés: $\pi 2$, $\pi 3$, $\pi 4$, $\pi 5$, $\pi 6$; sur quelques spécimens, $\pi 5$ et $\pi 6$ conent en un seul épaississement $\pi 5,6$; sur l'exemplaire dessiné en *n'* il y a dissytrie, $\pi 5$ et $\pi 6$ étant séparés à gauche et confluents à droite.

marques sur les *Lamippella* de *Rolandia coralloides*.

Avant de terminer cette étude sur *Lamippella faurei* B. et D., je tiens à signaler cas des spécimens de cette espèce recueillis dans *Rolandia coralloides* Lac.-Duth., s du sexe mâle, hormis le cas d'un spécimen, juvénile encore, et dont certains actères semblent indiquer un début de spéciation. Nous appellerons cette forme

mippella faurei rolandiae n. ssp.

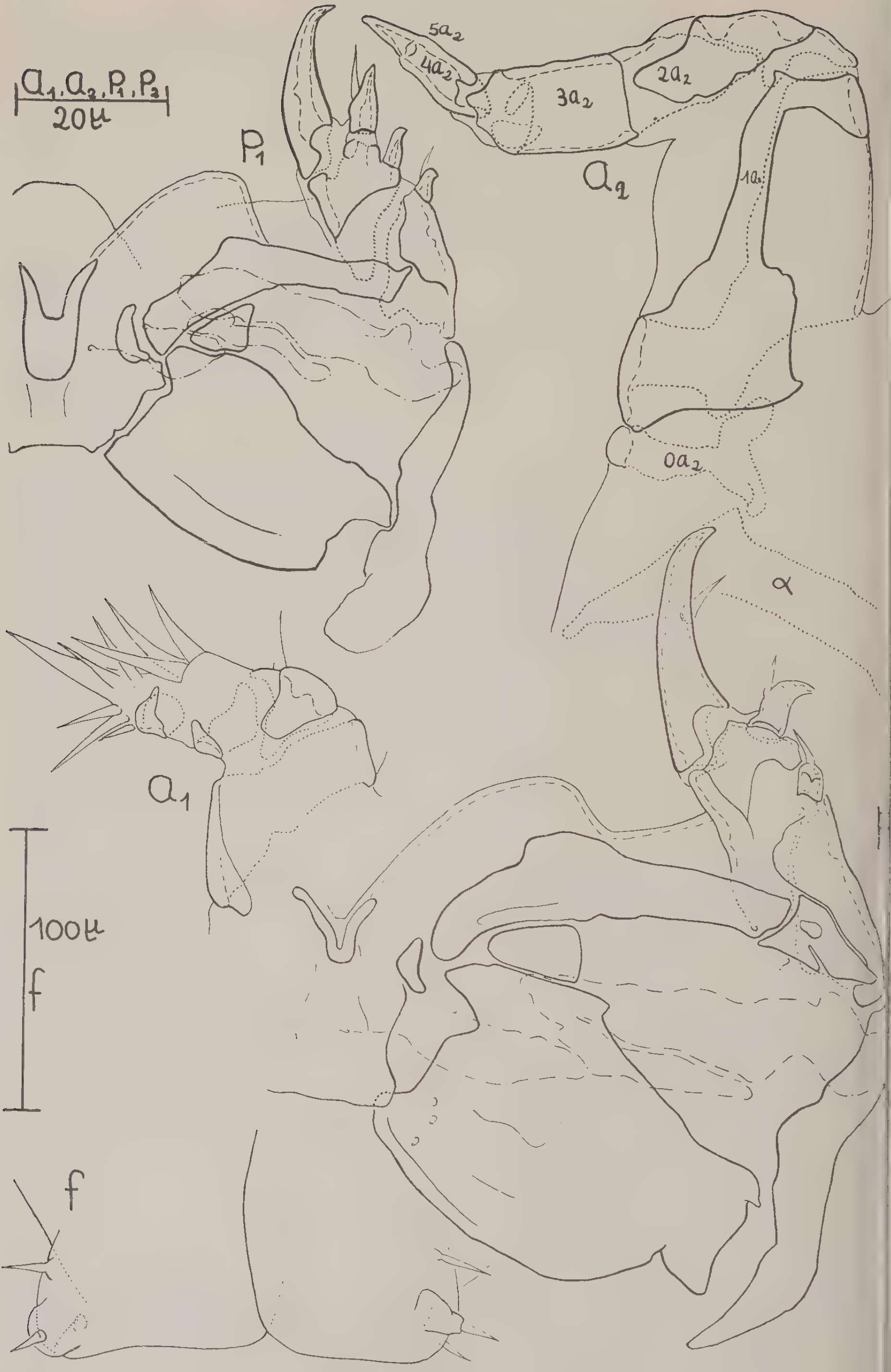

a1, a2, p1, p2
20µ
p1
5a2
4a2
3a2
2a2
1a2
a2
0a2
α
a1
100µ
f
f

Fig. 8. *Lamippella faurei* B. et D. — *a*1: antennule; *a*2: antenne; *p*1 et *p*2: première et deuxi
pattes thoraciques gauches; *f*: furca; tous ces dessins sont exécutés en vue ventrale.

es appendices et les sclérifications nucales restent semblables aux descriptions nées dans les pages précédentes. Cependant, les branches de la furca sont coni- s et aussi longues que la distance séparant deux rangées consécutives de papilles; que branche est munie d'une soie terminale petite et de deux soies latérales s longues. Les papilles sont elles-mêmes plus grandes par rapport aux appen- es.

e porte un intérêt particulier à cette sous-espèce, parce que les préparations rphologiques montées dans le Marc-André mettent en évidence des rangées cir- ires 2) de sclérifications alternant avec les rangées papillaires. Ces sclérifications blent indiquer la frontière de deux segments contigus et, à leur niveau, on ob- ve une legère constriction du corps; ainsi le segment génital est encadré par deux gées segmentaires; entre *p2* et le segment génital, on trouve trois segments por- t en leur partie médiane une rangée de papilles; entre la furca et le segment ital, on observe de même deux segments abdominaux (Bouligand et Delamare- outteville, 1959 b).

UN GENRE NOUVEAU, *LAMIPPINA* BOULIGAND, CRÉÉ POUR *L. ACICULIFERA* (DE ZUL.) ESPÈCE À DIMORPHISME SEXUEL

Les deux espèces créées par de Zulueta, *Lamippe aciculifera* et *L. brementi* para- nt les mêmes hôtes, *Alcyonium palmatum* Pallas et *A. acaule* Marion. Cet auteur it noté que les mâles de la première espèce et les femelles de la seconde étaient onnus. Mes observations permettent d'établir la parfaite identité entre ces deux èces, différentes seulement par la taille et la présence d'une griffe supplémen- re sur la patte *p2* de *L. brementi.* Cette identité morphologique et la coexistence ns le même hôte me font penser que ce sont les mâles et les femelles d'une seule même espèce.

A. de Zulueta a décrit chez *Parerythropodium coralloides* (Pallas) un parasite il a appelé *Lamippe papillifera* et dont le mâle restait également inconnu. *L. pillifera* et *L. aciculifera* sont morphologiquement identiques et la plupart des ites ornementations se retrouvent dans les mêmes proportions. Pour bien mon- r que je mettais en évidence un léger dimorphisme sexuel chez *L. aciculifera,* asite des Alcyons, je devais retrouver chez les *Parerythropodium* une forme nblable à ce *L. brementi* qui n'y avait pas été décrit; j'ai trouvé effectivement petits mâles exactement semblables à ceux des Alcyons. Certains caractères me duisent à créer un genre nouveau pour cette espèce; la nuque porte en effet des ississements chitineux extrêmement marqués; les pattes sont très élargies et tent une rame interne digitée; tous les épaississements chitineux sont de forme s allongée. Nous avons nommé ce genre *Lamippina* et nous ne garderons que *mippina aciculifera* (de Zul.) [syn.: *L. papillifera* (de Zul.)], parasite d'*Al- nium* et de *Parerythropodium.*

) Le plan défini par chacune est perpendiculaire à la direction générale de l'animal.

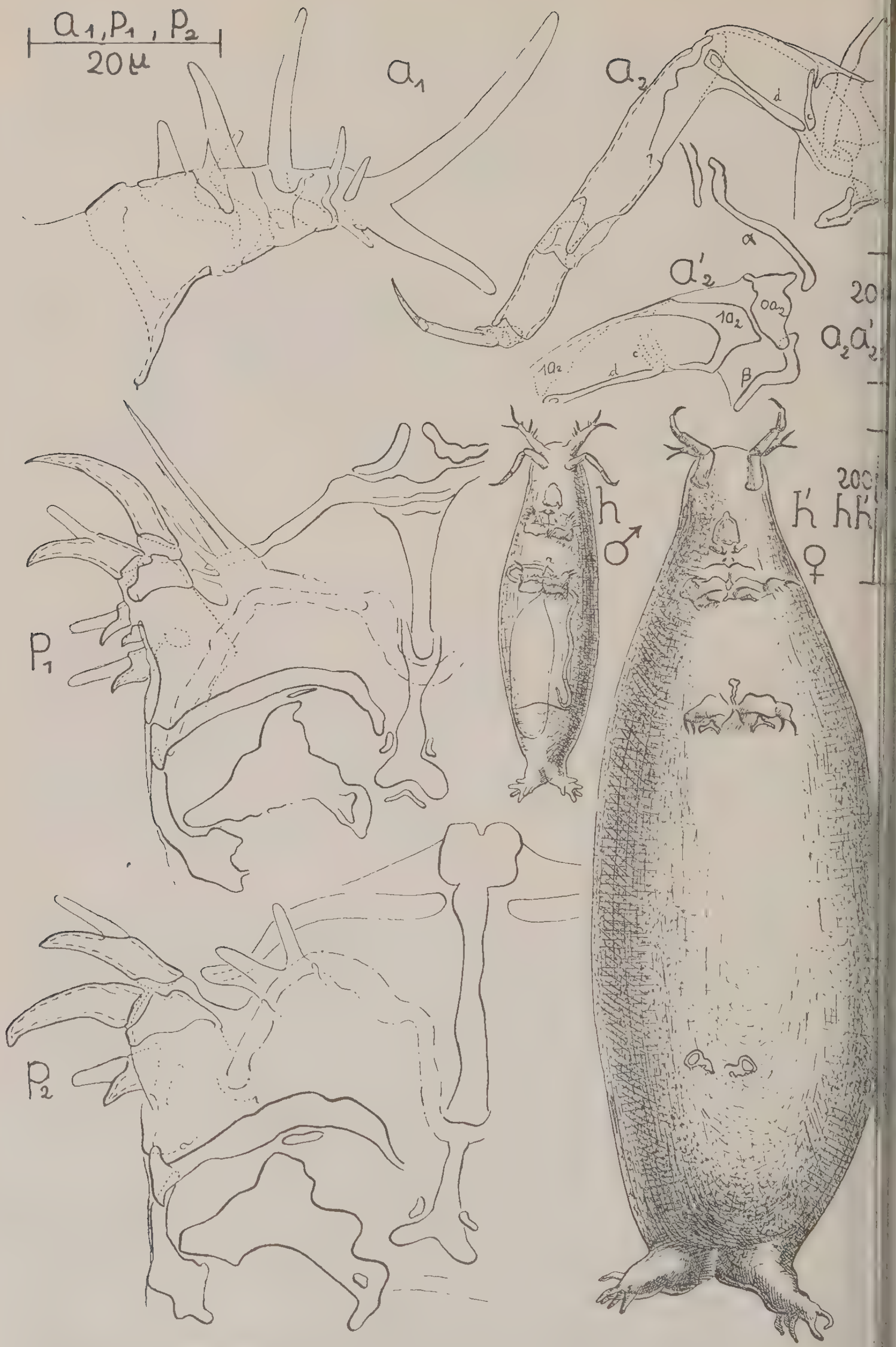

a1, P1, P2
20µ
a1
a2
d
c
α
a'2
0a2
1a2
β
1a2
d
c
20
a2a'2
h
♂
h'
♀
200
hh'
P1
P2

Fig. 9. *Lamippina aciculifera* (de Zul.) (*h*, *a1*, *a2*, *p1*, *p2*: mâles; *h'*: femelle). — *h*, *h'*: habitu
a1: antennule; *a2*: antenne; *a'2*: partie proximale de *a2* en vue latérale; *p1* et *p2*: première et deuxiè
pattes thoraciques droites; toutes les figures sauf *a'2* sont en vue ventrale.

Matériel étudié représenté sur les fig. 9, 10 et 11.
♂: spécimen n° 1 sur lequel ont été étudiés *h, a1, a2, p1, p2*; *n*, et spécimen
'. — ♀: spécimen n° 1: *n, v, f*; spécimen n° 2: *n'*; spécimen n° 3: *a1, a2*; spéci-
n n° 4: *h, p1* et *p2*.

imensions. Femelle: 1,1 mm de longueur; 0,3 à 0,4 mm de largeur;
le, 0,4 à 0,5 mm de longueur, largeur 0,12 mm.

oloration. Femelle rouge orangé; mâle beige très clair.

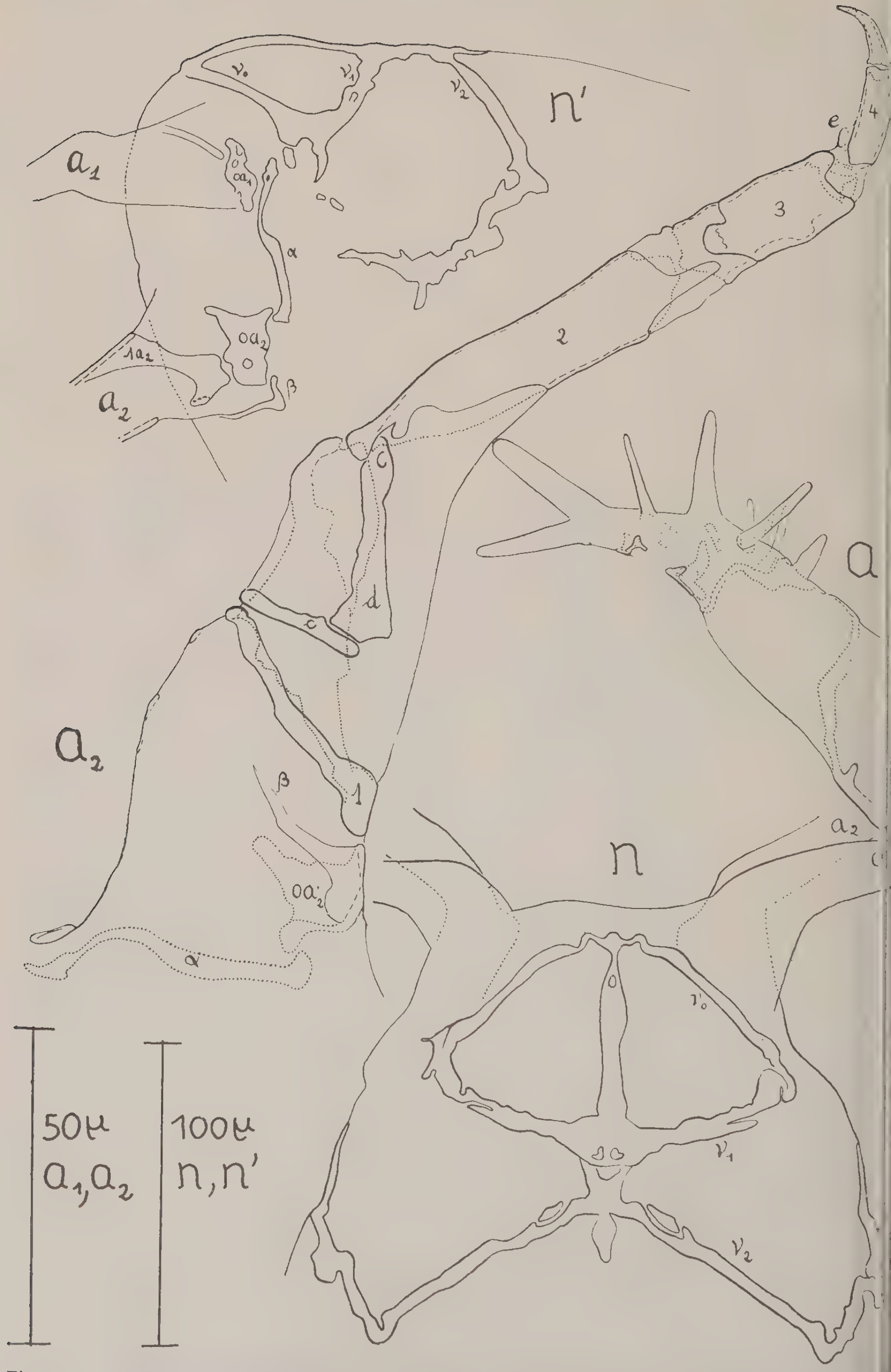
orme et mouvements. Le corps entier, en forme de fuseau, présente
portion céphalique très légèrement séparée par les épaississements nucaux
l'animal progresse en donnant des coups d'antenne très violents, filmés par M.
n Painlevé. La progression se fait par saccades, le péristaltisme est assez léger,
lus intense chez le mâle. L'allongement des pièces chitineuses le long des appen-
es semble plus marqué chez la femelle que chez le mâle.

ppendices

ntennule (*a1*) (fig. 9, fig. 10). — Les épaississements *1a1, 2a1* et *3a1*
etrouvent; *2a1* porte deux soies homologuées à *1s2a1* et *2s2a1*; on peut distin-
r sept soies antérieures, deux terminales et une dorsale, qui n'est attachée à
un épaississement; *4a1* est donc probablement disparu, puisque, chez les autres
èces étudiées, c'est sur lui que s'insère cette soie dorsale. Les deux soies ter-
ales sont presque égales et il est difficile de les identifier. Il n'y a pas de soies
térieures et parmi les soies antérieures on peut en compter une supplémentaire
rapport à *Enalcyonium rubicundum*. L'antennule du mâle porte quelques épais-
ements ventraux inexistants chez les femelles.

ntenne (*a2*) (fig. 9, fig. 10). — Elle est très développée; on trouve *0a2*,
. *2a2*. *3a2*. *4a2* et *5a2*; il y a en outre deux épaississements *c* et *d* au niveau
1a2, et ils en sont peut-être dérivés. On distingue les articulations suivantes:
α, *0a2*); *c* (*0, 1*); *c* (*1, 2*); *c* (*2, 3*); *c* (*3, 4*). *c* (2, 3) est ventral; entre les
x segments 2 et 3, il existe une saillie ventrale de *2a2* s'engageant dans une
oche de *3a2*; entre *4a2* et *5a2*, on trouve *a* et *b* et un petit épaississement "*e*"
ançant sur la paroi antérieure de *4a2*; *c* et *d* donnent les articulations *c (1, c)*;
c, d); *c (d, 2)*. Cette antenne est donc très modifiée dans l'ensemble par rapport
elle de *E. rubicundum*. En effet, il y a une seule articulation *c (0,1)* et trois
ississements nouveaux *c, d*, et *e*: *0a2* est non seulement articulé avec α, mais avec
aississement chitineux latéral.

es pattes *p1* et *p2* (fig. 9 et 11). Elles sont décrites dans le travail de de Zu-
a; il n'avait pas observé les rames internes digitées de *Lamippina aciculifera*;
s existent néanmoins ainsi que chez les exemplaires recueillis sur les *Pare-*
ropodium. La caractéristique la plus saisissante de ces pattes est le grand allon-
ent des sclérifications qui les soutiennent; les épaississements impairs *i* et *j* sont
bien individualisés; sur *p1*, *i* est en forme de *T* renversé et *j* en forme de *T*
it dont les deux branches sont deux fois plus longues que la partie longitudinale.
épaississements *i* et *j* subissent une importante modification en *p2*, où *i* est
forme de *X* et *j* ne présente pas de branches transversales. De petits sclérites



n'
ν_0
ν_1
ν_2
a_1
oa_1
α
oa_2
$1a_2$
a_2
β
4
e
3
2
c
d
c
a_2
1
β
oa'_2
α
a
n
a_2
ν_0
ν_1
ν_2
50µ
a_1, a_2
100µ
n, n'

Fig. 10. *Lamippina aciculifera* (de Zul.) femelle: *n'*: vues dorsale et latérale des sclérificat céphaliques; *a*1, *a*2: antennule et antenne en vue ventrale.

t apparus au niveau des articulations *c* (*i, a*) et *c* (*i, b*). La séparation de *d* en ix sclérites *d1* et *d2* n'est pas nette, et un sclérite intermédiaire semble être paru. On peut reconnaître en outre les articulations *c* (*a, c*); *c* (*c, b*); *c* (*d, b*) l'arête articulaire *a* (*b, e*). L'arête articulaire *a* (*d, e*) semble réduite à un con- e. La rame externe est soutenue par un seul sclérite dont nous pensons qu'il est quivalent de *e* et *f* de *E. rubicundum*; nous l'appellerons "*e, f*" et il est disposé le côté le plus extérieur de cette rame.

ur *p1* ce sclérite porte cinq griffes dont la plus distale, qui est la plus forte, ne te pas de soies latérales. Les quatre griffes les plus proximales sont moindres portent des soies latérales.

ur *p2,* chez la femelle, le sclérite (*e, f*) porte deux griffes seulement avec soie latérale chacune contrairement au mâle où (*e, f*) porte trois griffes laté- es (la griffe médiane est seule à ne pas porter de soies latérales). Du côté le s interne de cette rame, on observe trois gros mamelons subcylindriques portant bouquets d'acicules (non figurés sur le schéma) et que de Zulueta avait assi- és à des papilles chez *L. papillifera.*

a rame interne porte sur *p1* un sclérite sur la face qu'elle tourne vers le corps lle présente au maximum sept digitations; la rame de *p2* porte cinq digitations nconiques aciculifères et est munie d'une sclérification du côté du corps et d'une re sur le côté ventral.

Vulves ovigères et fentes de libération des spermatophores. Les cadres ovigères, nblables à ceux de *E. rubicundum,* portent un fort développement des parties plus médianes de la pince en cuilleron destinée à saisir les spermatophores. La te Δ n'est pas ornementée.

a furca est formée de deux branches tronconiques portant trois digitations ter- nales et deux ventro-latérales; chaque digitation porte un bouquet d'acicules.

es sclérifications nucales (fig. 10, *n, n'*) forment un dessin très précis et nous ivons reconnaître les branches *v1* et *v2*. En outre, une branche plus antérieure conflue latéralement avec *v1* (fig. 7, *n* et *n'*); le triangle formé par *v1* et *v0* t être tapissé par une sclérification plus fine, percée de nombreux trous décelés a microscopie en contraste de phase. Cette fine sclérification a été observée out chez *L. papillifera.*

Sclérifications latérales (fig. 10, *n'*). — On observe α articulée sur *a1* et *a2*; épaississement β à la base de *a2* n'avait par d'équivalent chez les autres Lamip- es étudiés.

UELQUES DONNÉES SUR LES PROBLÈMES DE LA SPÉCIFICITÉ PARASITAIRE ET DE LA SPÉCIATION CHEZ LES LAMIPPIDES

A. de Zulueta avait montré dans son travail qu'une même espèce d'Octocoral- re pouvait être parasitée par plusieurs espèces distinctes de Lamippides 3); nous

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Muricea chamaeleon von Koch est souvent parasité simultanément par *Linaresia mammillifera* Zul.), *Enalcyonium parvum* (de Zul.) et *E. setigerum* (de Zul.); on serait en droit de se deman-

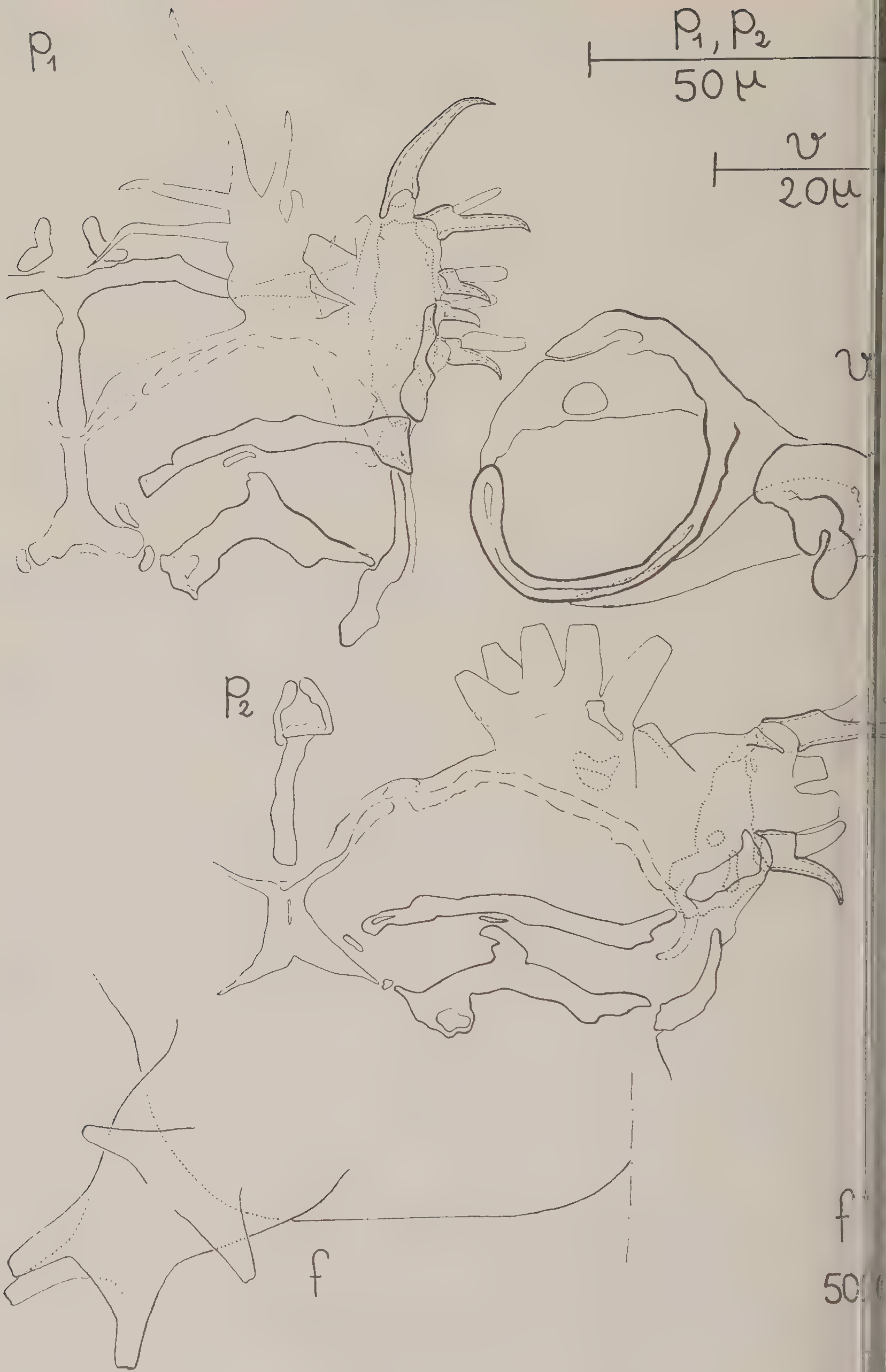
P1
P1, P2
50 µ
v
20 µ
v
P2
f
f
50

Fig. 11. *Lamippina aciculifera* (de Zul.) femelle: p_1 et p_2: première et deuxième pattes thorac gauches; *v*: vulve ovigère; *f*: furca; toutes ces figures sont en vue ventrale.

ns trouvé des Alcyons abritant simultanément trois espèces distinctes; dans
pages précédentes, nous avons montré que certaines espèces se retrouvent, sans
ification morphologique, dans des Octocoralliaires très différents. C'est le cas
amippella faurei B. et D. recueillis sur *Eunicella verrucosa* (Pallas), *Alcyonium*
atum Pallas et *Parerythropodium coralloides* (Pallas). Cette identité mor-
ogique n'exclut pas, entre les spécimens provenant d'Octocoralliaires diffé-
s, des distinctions spécifiques d'ordres biologique, physiologique et chimique.
lques exemplaires recueillis sur *Leptogorgia sarmentosa* (Esp.) étaient exacte-
t semblables par leur morphologie à *Enalcyonium pallidum* (de Zul.); on
eille régulièrement ce Copépode sur les Véretilles. On peut noter que les élé-
ts du paysage sous-marin qui renferment respectivement les Véretilles et les
ogorgia peuvent avoir une frontière commune. La spécificité des Lamippides
leur hôte est donc moins absolue que ne l'indique de Zulueta; cette spécificité
pourtant vérifiée dans la plupart des cas [4]). Toutefois, il semble que les Oc-
alliaires de même genre et d'espèces différentes renferment les mêmes espèces
arasites. La spécificité n'est d'ailleurs pas de règle chez les Copépodes parasites:
les Ascidicolidés constituent un ensemble d'espèces dont la plupart sont con-
dans plusieurs hôtes: "on doit s'attendre, dans des recherches ultérieures sur
Ascidicolidés, à ce que dans cette famille, le phylum du parasite se montre
pendant du phylum de l'hôte" (Brément, 1909). Il n'est pas possible d'établir
arallélisme entre l'évolution des Octocoralliaires et celle des Lamippides. Parmi
amippides de Banyuls, les espèces abritées par un hôte commun sont en général
différenciées entre elles que certaines espèces voisines inféodées à des hôtes
différents; nous n'arrivons pas à percevoir, grâce aux données morphologiques
nous disposons, l'adaptation particulière d'un parasite à une espèce bien pré-

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ces espèces sont bien distinctes ou ne sont pas au contraire des stades morphologiquement dif-
s du cycle biologique d'une même espèce. Il faut adopter la première hypothèse parce que nous
issons des Octocoralliaires qui ne renferment qu'une seule espèce de Lamippide, se présentant
rs avec la même morphologie. [*Paralcyonium elegans* (M. Edw.) renferme seulement *Enalcyo-*
duthiersi (Joliet), *Veretillum cynomorium* (Pallas) n'est parasité que par *E. pallidum* (de
et *Pteroides griseum* Bohadsch par *E. pallidum* (de Zul., 1908). Nous contestons la valeur de
e *Lamippe pteroidis* de Zul., 1910.] Par ailleurs, si certaines espèces A, B, etc. . . . ., décrites
n Alcyonaire formaient une association nécessaire parce qu'elles représentent en fait quelques
du cycle d'une seule espèce, on devrait retrouver, dans les types différents d'Octocoralliaires
nferment des Lamippides A', voisins morphologiquement de A, une association parallèle A', B',
. ., où B' serait très voisin de B (il faudrait admettre dans ce cas que des espèces morpholo-
voisines auraient des cycles biologiques voisins). Ainsi *Eunicella verrucosa* (Pallas) renferme
èrement *Enalcyonium affinis* (de Zul.) et *Lamippella faurei* B. et D. (et seulement ces deux
s, semble-t-il); *Leptogorgia sarmentosa* (Esp.) renferme régulièrement *Enalcyonium pusillum*
ul.) dont l'extrême ressemblance avec *E. affinis* avait déjà été observée par de Zulueta; cepen-
nous n'avons jamais trouvé de *Lamippella faurei* dans les *Leptogorgia*: ceci nous confirme que
mippella faurei ne sont pas des stades particuliers d'espèces déjà connues.

De la même manière, nous n'avons jamais trouvé d'*Enalcyonium sympodii* (de Zul.) et de *E. seti-*
(de Zul.) parasitant d'autre hôte que, respectivement, *Leptogorgia sarmentosa* (Esp.) et *M.*
eleon von Koch (contrairement à de Zulueta qui les a décrits en leur attribuant *Sympodium*
ides comme hôte).

cise d'Alcyonaire; indiscutablement, le parasite présente les caractères d'une
adaptation à la vie à l'intérieur des Octocoralliaires, les caractères spécifiqu
l'hôte quel qu'il soit ne semblent pas avoir d'influence sur l'évolution mor
gique des parasites.

Avant d'aborder le problème de la spéciation, il est utile de connaître les fa
susceptibles de limiter l'expansion d'une espèce de Lamippides. Nous n'
jamais trouvé d'Octocoralliaires dont l'état soit compromis par la présence
parasites, qui restent en général très peu nombreux dans un même hôte; les L
pides se nourrissent d'oeufs, d'endoderme, et de débris de mésoglée, mais
luttent jamais entre eux. La prolifération des Lamippides pourrait être li
pendant la phase libre; deux espèces se rencontrant à l'état adulte dans le
hôte ont pu avoir des phases libres bien différentes par la localisation ou l'ép

SUMMARY

The third note in the series on the Lamippidae has a detailed description of the type spe
the genus *Lamippella, L. faurei* Bouligand & Delamare. This parasite occurs in *Alcyonium*
rythropodium, and in *Eunicella,* Octocorals which are phyletically very distant from one a
yet the specimens do not show any morphological differences. It is not known whether the spe
exhibit, according to the host, specific differences of a biological, physiological or chemical
or whether they form an exception to the host specificity, which is rule in the Lamippidae.

In the fourth note, the species *Lamippe aciculifera, L. brementi* and *L. papillifera* are sh
belong to one and the same species *Lamippina aciculifera,* type of a genus established in a p
note, in which there is marked sexual dimorphism.

Finally, it is shown that, although the rule of host specificity has few exceptions in the Lami
no parallel evolution of the host species and the parasite could be demonstrated (note 5).

Reçu: le 7 juin 1960.

UR LA MORPHOLOGIE EXTERNE DES LARVES DE PAGURIDES.
I. *CATAPAGUROIDES TIMIDUS* (ROUX)

PAR

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ns un travail publié en 1958, en collaboration avec J. Forest, nous avons t la glaucothoé de *Catapaguroides timidus* (Roux), Pagure appartenant à la famille des Pagurinae. Nous donnons ici une description détaillée des stades ires (zoé I à zoé IV) de cette espèce.

e zoé I attribuée à *C. timidus* a été sommairement décrite en 1910 par Issel. 921, Boraschi a figuré le telson de ce stade, vraisemblablement d'après un men d'Issel. Dans un très récent travail sur les larves de Pagurides de la baie aples, dont nous avons pris connaissance alors que la présente note était prati- ent achevée, Pike et Williamson (1960) ont donné les caractères principaux ifférents stades de *Catapaguroides* et ont très justement relevé que les zoés I es ou figurées par Issel et Boraschi n'appartenaient vraisemblablement pas à espèce, mais ressemblaient beaucoup plus aux larves des *Anapagurus,* quoique oup plus petites. Pike et Williamson ont émis l'hypothèse qu'il pouvait s'agir zoé I de *Nematopagurus longicornis.* Notons cependant que Boraschi a indi- ue la larve en question était très abondante dans le plancton de surface, d'avril bre. Or, ni Pike et Williamson à Naples, ni nous-mêmes à Banyuls-sur-Mer, ns recueilli, au cours de très nombreuses pêches planctoniques effectuées pen- cette période, de larves identifiables avec certitude à celles d'Issel et de chi.

us avons noté entre nos larves et celles de Pike et Williamson quelques rences dont certaines peuvent être imputables aux conditions écologiques, rentes en baie de Naples et dans la région de Banyuls.

matériel que nous avons étudié a été recueilli au cours de pêches planctoniques la région de Banyuls-sur-Mer pendant les étés 1958 et 1959. Les 4 stades lar- s ont été identifiés par la méthode des élevages partiels successifs exposée par Donald, Pike et Williamson (1957, p. 211).

s caractères généraux des larves de Paguridae sont bien connus (cf. Gurney, ; Mac Donald, Pike et Williamson, 1957; Pike et Williamson, 1960), au s pour les formes de nos régions. Quelques bons caractères, tels que taille, e du telson, épines sur le bord postérieur des tergites abdominaux, nombre de pléopodes, nombre et dispositions des chromatophores, etc. . . — employés no ment par les auteurs précités — permettent l'identification spécifique, ma n'existe pas de travaux comportant une description précise et une figuration taillée des différents appendices, et montrant leur évolution au cours du dévelo ment. Ce premier travail ne permettra donc de faire porter la comparaison entr larves de *C. timidus* et celles d'autres Paguridae, que sur les caractères géné décrits par les auteurs, à l'exclusion des appendices.

Dans les descriptions qui suivent, nous avons préféré suivre l'évolution des di ses régions du corps et des différents appendices, plutôt que de donner succes ment les caractères de chaque stade.

Les dessins d'un appendice donné sont placés côte à côte (de gauche à dr stades I à IV) ou sur la même ligne verticale et sont à la même échelle pou quatre stades, ce qui permet de suivre la variation des dimensions au cours

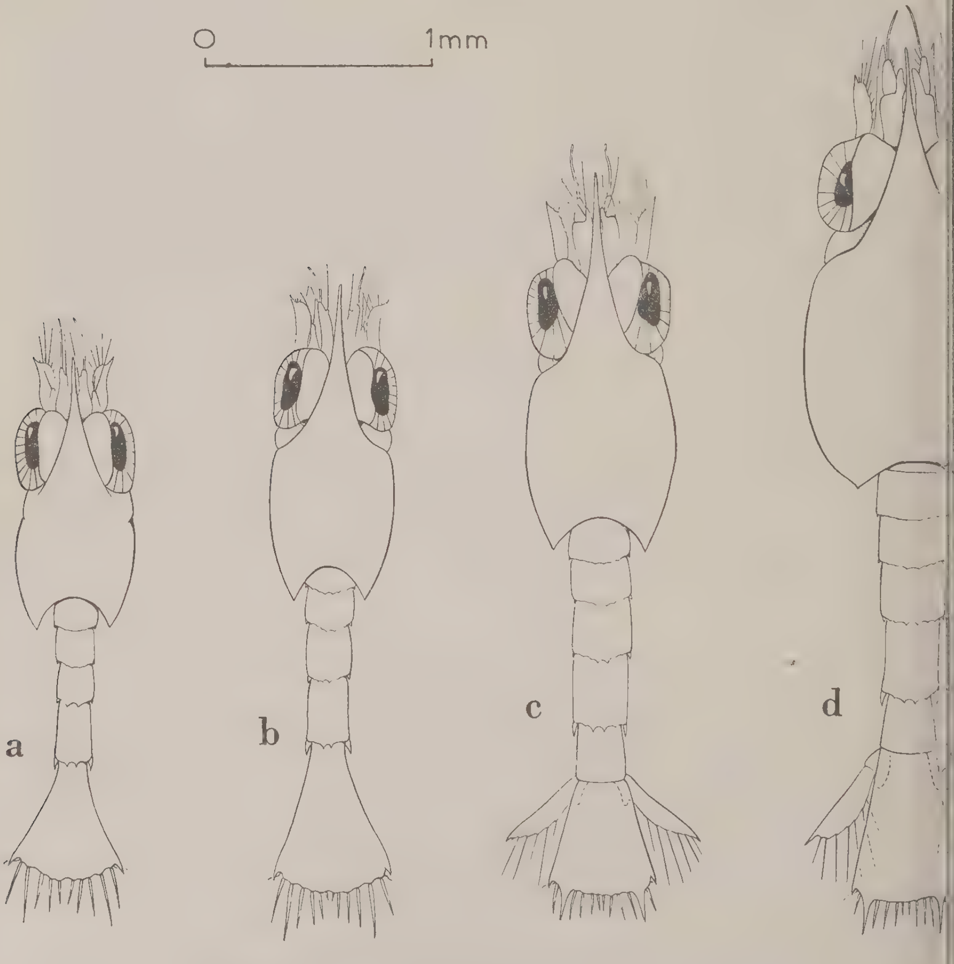


Fig. 1. — *Catapaguroides timidus* (Roux): a, zoé I; b, zoé II; c, zoé III; d, zoé IV.

eloppement. Chaque appendice est désigné par un chiffre arabe qui indique son g, et par une lettre dénotant le stade: a à d, pour les stades I à IV respectivement. dessins, sauf ceux d'ensemble, ont été exécutés d'après des préparations entre e et lamelle.

DIMENSIONS (en mm)

les	I	II	III	IV
gueur rostre-épines carapace	1,1 à 1,3	1,3 à 1,5	1,5 à 1,7	1,7 à 1,9
gueur rostre-bord postérieur du telson	2,2 à 2,4	2,6 à 2,8	3,0 à 3,2	3,6 à 3,9

orme générale (fig. 1) assez allongée par rapport aux larves du genre *Pagurus,* out aux stades III et IV.

éphalothorax (fig. 1). — Rostre étroit, dépassant de peu l'extrémité des ennes et des antennules. Carapace relativement courte, son bord postérieur atteint iblement le milieu du 2ème segment abdominal au stade I. Accroissement en gueur de 1/6 à 1/7 à chaque mue. — Epines latéro-postérieures de la carapace marquées et recourbées vers le bas (fig. 13).

bdomen (fig. 1 et 2). — Bord postérieur des segments abdominaux armé de x épines médio-dorsales et d'une paire d'épines latérales, de plus en plus développées du premier au dernier segment. Epines médio-dorsales particulièrement isées et épines latérales longues sur le 5ème segment (caractère commun avec espèces du genre *Pagurus,* cf. Pike et Williamson, *loc. cit.,* p. 524). En outre d postérieur des segments 2, 3, 4, et 5 armé de 2 paires de denticules plus ou ns marqués entre les épines médio-dorsales et latérales. Au stade IV des denles supplémentaires apparaissent sur le segment 5 (fig. 2d).

Jne épine anale, petite et pas toujours visible aux stades I et II, plus développée stades suivants.

ixième segment abdominal fusionné avec le telson aux stades I et II. Aux stades et IV, le 6ème segment porte, en plus de l'épine anale, une paire d'épines venes postéro-latérales, sous l'articulation des uropodes.

elson (fig. 2). — *Stade I.* — Bord postérieur fortement convexe. Comme z la plupart des Anomoures, 6 paires d'épines terminales, dont les 5 paires rnes articulées, et 1 paire de soies fines entre la 1ère et la 2ème. Les épines artiées portent latéralement de fines barbules. Bord postérieur du telson, entre les nes, avec des spinules microscopiques. Echancrure médiane peu importante. Lonur de la plus longue épine (3ème de l'extérieur) un peu supérieure à la moitié iron de la longueur du telson et du 6ème segment fusionnés. Longueur totale telson et du 6ème segment légèrement supérieure à sa largeur maximale.

tade II. — Convexité du bord postérieur atténuée. L'échancrure médiane a aru et à son emplacement apparaît une 7ème paire d'épines beaucoup plus rtes. La plus longue épine, deux fois et demie plus courte que l'ensemble telson ème segment, dont la longueur est maintenant nettement supérieure à la largeur pport voisin de 4/3).

Stade III. — Sixième segment abdominal distinct du telson, dont le bord p rieur est encore légèrement convexe. Epines de la troisième paire, toujours les longues, désormais fusionnées avec le telson et dépourvues de barbules. Rap largeur/longueur égal à 5/6 environ.

Stade IV. — Bord postérieur presque droit. — Rapport largeur/longueur à 2/3.

APPENDICES

Antennule (A 1) (fig. 3). — Longueur sensiblement égale à celle des C'est un appendice simple, non articulé aux stades I et II, environ 4 fois plus l que large.

Stade I. — L'antennule porte à son extrémité une large soie sensorielle ruban et quelques autres soies plus courtes. Dans la région subdistale, un petit bourg ébauche du fouet interne, porte une longue soie plumeuse.

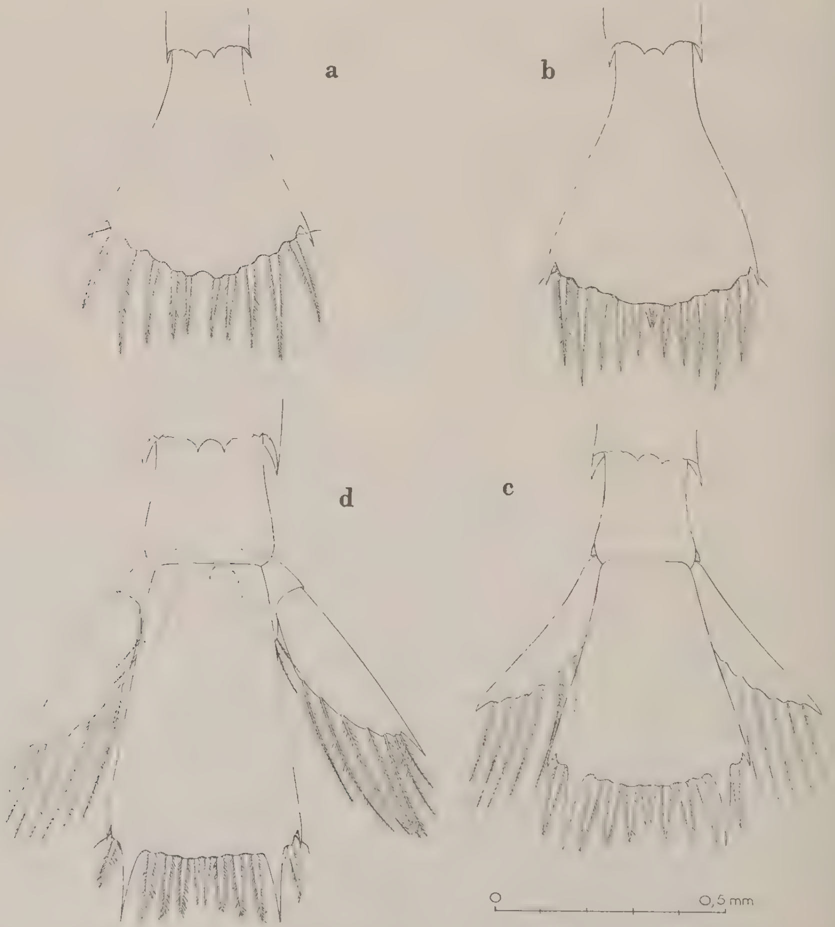
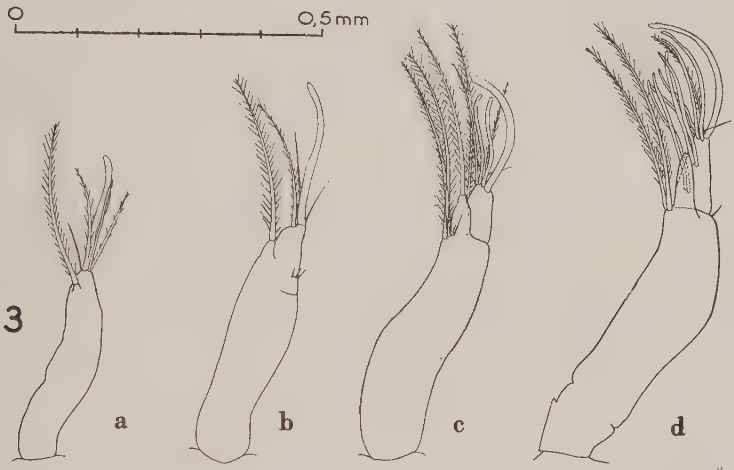


Fig. 2. — Extrémité de l'abdomen de *Catapaguroides timidus* (Roux): a, zoé I; b, zoé II; c, zoé d, zoé IV.

Stade II. — Augmentation de taille, sans modification du nombre des soies, et ongement du bourgeon subdistal.

Stade III. — Soies sensorielles plus nombreuses (3 à 4). L'extrémité de l'appen e s'est articulée au niveau de l'insertion de la rame interne; celle-ci, non articulée, t développée et porte toujours une longue soie plumeuse à l'apex; à sa base sèrent deux longues soies plumeuses.

3



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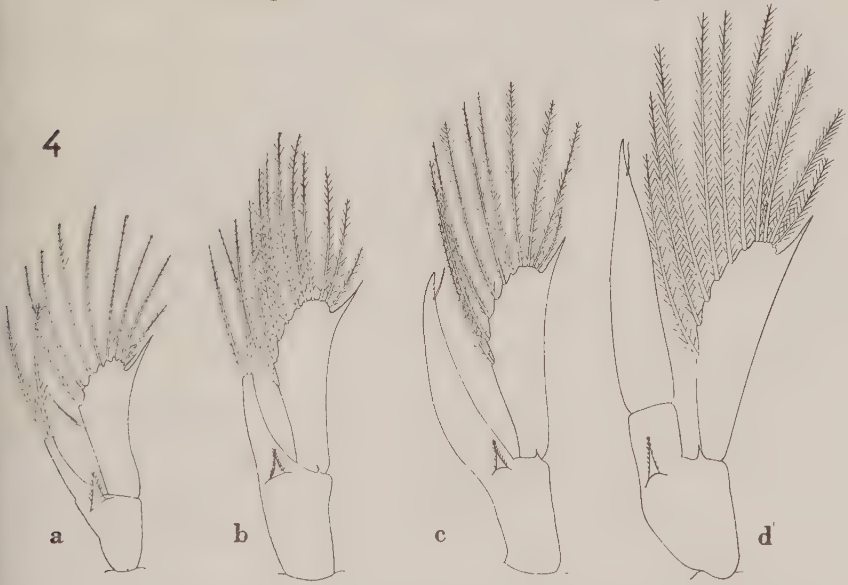


3-4. — *Catapaguroides timidus* (Roux): 3, antennule: 4, antenne. a, zoé I; b, zoé II; c, zoé III; d, zoé IV.

Stade IV. — Les soies sensorielles sont maintenant disposées sur le bord interne l'article terminal, en 3 groupes de 2 à 3. La rame interne a perdu sa soie plu-

meuse distale. Le basipodite s'est élargi et présente des traces de segmentation
sa région proximale.

Antenne (A 2) (fig. 4). — Endopodite non distinct du basipodite, sau
stade IV; vers le tiers distal s'articule l'exopodite représenté par une écaille dor
bord interne porte une rangée de soies plumeuses, et dont le bord externe lég
ment concave se termine en une épine; le rapport de la longueur de cette épine
longueur totale de l'article passe de 1/4 au stade I à 1/5 au stade IV. Le basipo
porte sur sa face ventrale, au niveau de l'insertion de l'écaille, une forte ép
serrulée.

Stade I. — L'extrémité de l'endopodite porte 2 longues soies plumeuses et att
sensiblement le milieu de l'écaille. Sur le bord interne de l'exopodite, on obser
soies plumeuses et une 10 ème, simple, subdistale, plus petite.

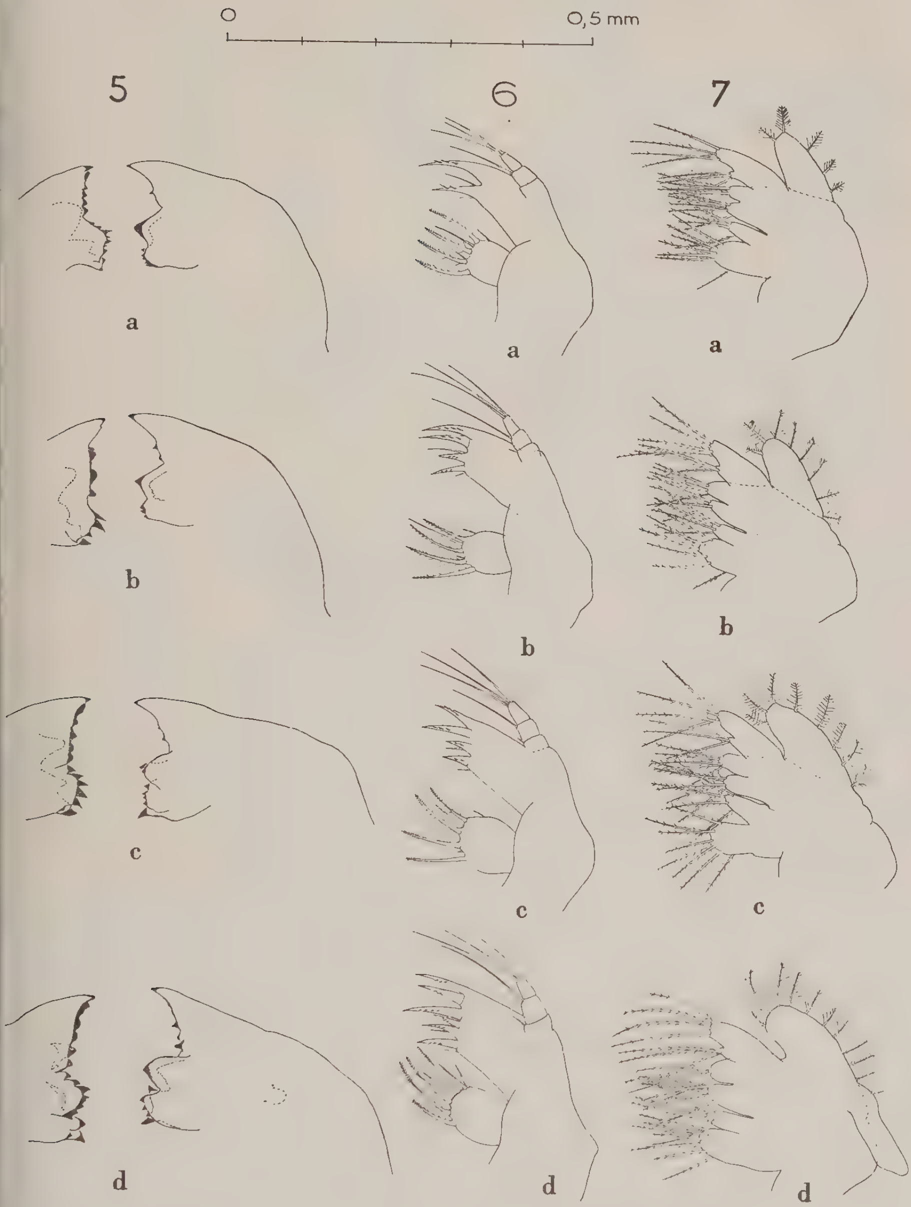
Stade II. — Augmentation de taille et apparition d'une petite épine vent
simple sur le bord antérieur du basipodite, sous l'articulation avec l'exopodite.
10 ème soie de ce dernier devient plumeuse.

Stade III. — L'endopodite atteint la région distale de l'écaille, a perdu ses d
soies distales, et ne porte plus qu'une petite soie simple, subterminale.

Stade IV. — L'endopodite dépasse l'écaille; il est articulé entre le tiers e
moitié de la longueur totale de l'appendice.

Mandibule (Md) (fig. 5). — Les mandibules, réduites à leur partie
ticatrice, sont divisées en une région antérieure sécante et une région postérie
molaire. Comme chez la plupart des larves de Décapodes, elles sont asymétriq
La région antérieure de l'appendice gauche forme une dent aiguë et saillant
ne présente que deux dents cornées, dans sa moitié proximale. Sur l'appendice dr
cette région est moins aiguë, et le bord sécant est armé de dents cornées tranchan
Il n'y a qu'un faible accroissement de taille d'un stade à l'autre, avec apparit
d'un rudiment de palpe au stade IV.

Maxillule (Mx 1) (fig. 6). — Se compose d'un basipodite portant d
endites et d'un palpe de 3 articles (endopodite).
Aux stades I, II, et III, l'endite proximal est bordé d'une rangée de 4 soies
bulées et de 3 soies simples plus fines. Une soie simple supplémentaire appa
au stade IV.
L'endite distal se termine au *stade I*, par 2 fortes dents serrulées, non articul
il y a 2 soies simples à la base de l'épine proximale. Au *stade II* une forte ép
également serrulée, s'articule à la base de chacune des deux dents fixes. Il n'
pas de modifications au *stade III*, mais au *stade IV*, on compte 4 épines articul
en plus des deux dents fixes.
Le palpe, de 3 articles, ne se modifie pas d'un stade à l'autre; il porte une s
simple interne sur le bord antérieur des 2 premiers articles et un groupe de
longues soies simples à l'apex du dernier article.



. 5-7. *Catapaguroides timidus* (Roux): 5, mandibules; 6, maxillule; 7, maxille. a, zoé I; b, zoé II; c, zoé III; d, zoé IV.

Maxille (Mx 2) (Fig. 7). — Comprend un basipodite avec deux endites obées, un palpe bilobé uniarticulé, l'endopodite, et le scaphognathite (exopo- e).

Le nombre de soies sur les endites est indiqué dans le tableau suivant:

	Stade I	*Stade II*	*Stade III*	*Stade I*
Lobe proximal de l'endite proximal	7	7	8	8
„ distal ” ”	4	4	4	4
„ proximal ” distal	5	5	5	5
„ distal ” ”	4	4	5	5

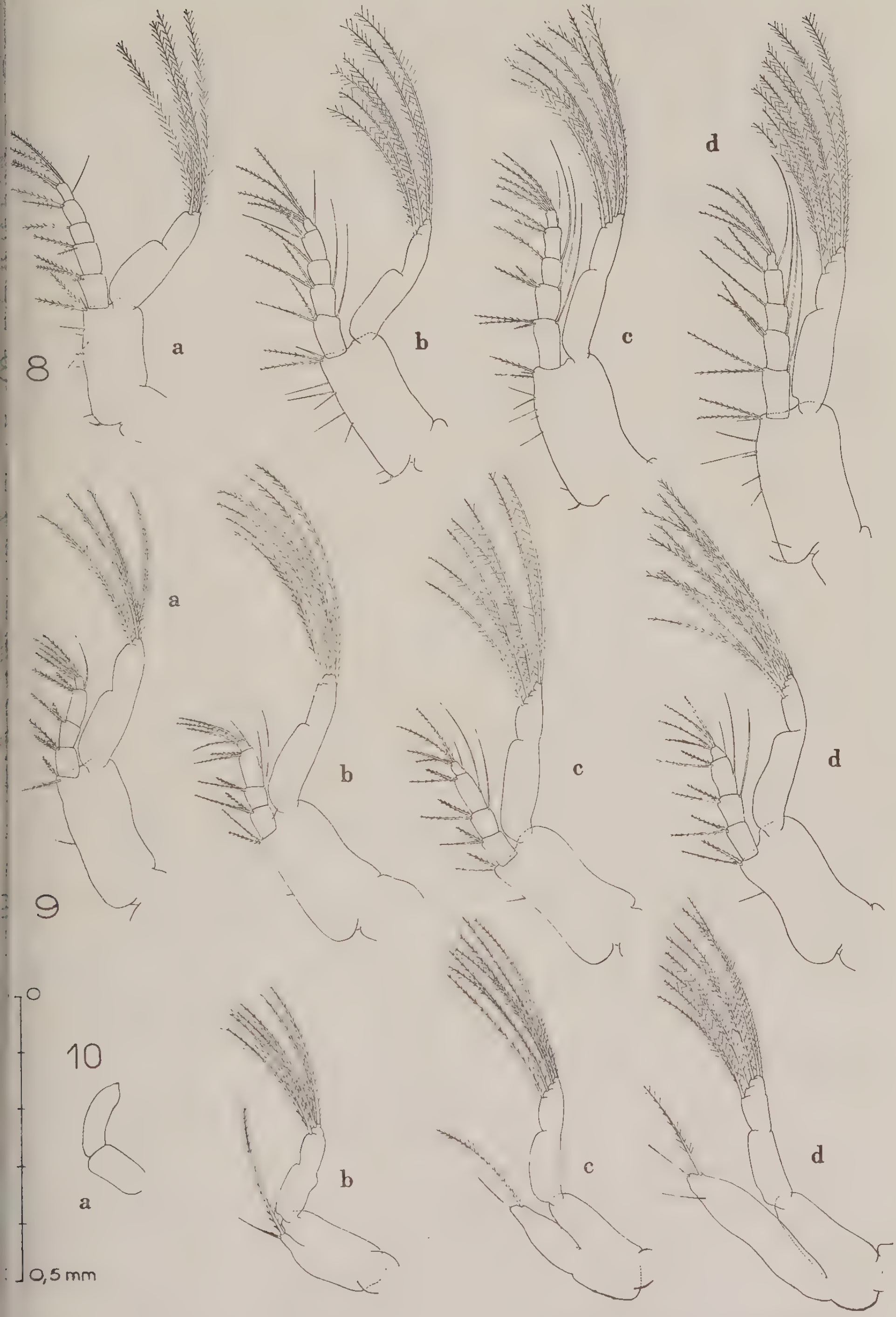
A tous les stades, le palpe est uniarticulé et porte une rangée de 4 soies t minales dans la région distale; le petit lobe interne est surmonté d'un groupe 3 autres soies. Le scaphognathite apparaît comme un lobe simple bordé de 5 so au stade I, de 8 soies au stade II, de 9 soies au stade III. Au stade IV, il y a soies et la forme du scaphognathite se précise par la formation d'une large expa sion proximale glabre.

1er Maxillipède (Mxp1) (fig. 8). — Il n'y a que peu de modi cations au cours du développement. Basipodite portant 10 soies, dont 2 distal plumeuses, sur le bord interne. La soie proximale, arquée, assez forte, semb particulière à cette espèce.

Endopodite de 5 articles. A tous les stades il y a respectivement sur le b interne des 4 premiers articles, 2 ou 3, 2, 1 et 2 soies barbulées distales, et, sur cinquième article, 4 soies barbulées distales et une soie simple subproximale le bord externe. Sur le bord externe des articles 1 à 4, il n'y a aucune soie au sta I, 1 longue soie simple distale sur les articles 1 et 2 au stade II, et, en plus, u soie distale sur l'article 3 au stade III et IV. Le bord externe du 4ème article toujours glabre.

2ème Maxillipède (Mxp2) (fig. 9). — Bord interne du ba podite avec une soie simple dans sa partie moyenne et deux fortes soies barbul distales, sous l'insertion de l'endopodite. Ce dernier formé de 4 articles dont les premiers portent 2 soies barbulées distales du côté interne; sur le 4ème article u groupe de 4 soies barbulées distales et une soie simple proximale sur le bo externe. Il y a en outre du côté externe, aux stades II, III et IV, une soie simp distale sur le 2ème article et une soie simple médiane sur le 3ème article. Exopodi avec une amorce de segmentation sur le bord interne et 4, 6, 7, 8 longues so plumeuses aux stades I, II, III et IV respectivement.

3ème Maxillipède (Mxp 3) (fig. 10). Au *stade I*, c'est un simp rudiment biarticulé, dépourvu de soies, dont le 2ème article peut être homologu l'exopodite. Au *stade II*, sur le basipodite prend naissance du côté interne, da la région subdistale, une ébauche d'endopodite surmontée de 2 soies dont la pl longue est plumeuse. L'exopodite semblable à celui des Mxp1 et Mxp2 présen une amorce de segmentation dans la région médiane et porte 6 soies plumeus distales. Au *stade III*, l'endopodite dépasse la base de l'exopodite, lequel est pourv de 7 soies plumeuses. Au *stade IV*, l'endopodite atteint le milieu de l'exopodi


8
a
b
c
d
9
a
b
c
d
10
a
b
c
d
0
0,5 mm

g. 8-10. — *Catapaguroides timidus* (Roux): 8, premier maxillipède; 9, deuxième maxillipède; 10, troisième maxillipède — a, zoé I; b, zoé II; c, zoé III; d, zoé IV.

et porte une soie simple supplémentaire du côté interne, dans la région subdist une 8ème soie est apparue sur l'exopodite.

Péréiopodes (p1 à p5) (fig. 11). — Les 5 paires de péréiopo existent dès le stade II sous la forme de bourgeons distincts dont les dimensi s'accroissent au stade III et surtout au stade IV. Les chélipèdes, les pattes am latoires p2 et p3, les p4 et les p5 ont dès lors une forme qui annonce celle c l'on observe chez l'adulte, mais ce sont des ébauches non fonctionnelles et s traces de segmentation. On distingue par transparence l'appendice de la glaucot en formation.

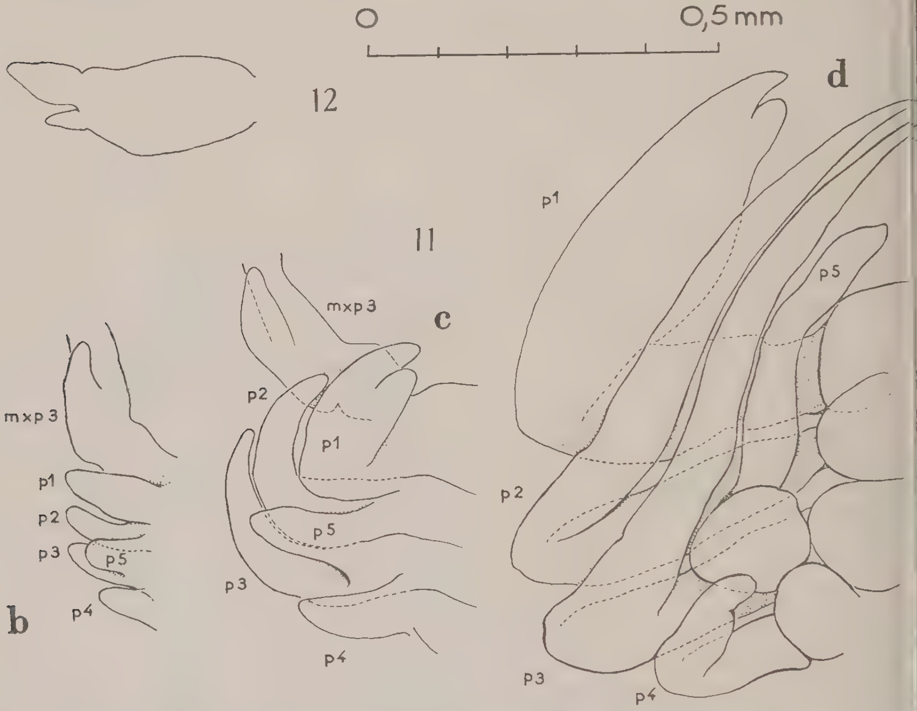


Fig. 11-12. — *Catapaguroides timidus* (Roux): 11, développement des appendices thoraciques pc rieurs: b, zoé II; c, zoé III; d, zoé IV. 12, pléopode, stade IV.

Comme chez les Galatheidae et les Hippidae, l'ébauche de la 5ème paire repliée et cachée sous les autres paires, donc seulement visible à la dissection.

Pléopodes. — Les pléopodes apparaissent au stade IV sur les segme abdominaux 2, 3, 4 et 5. Ce sont des ébauches biramées dont l'endopodite nettement plus court que l'exopodite (fig. 12).

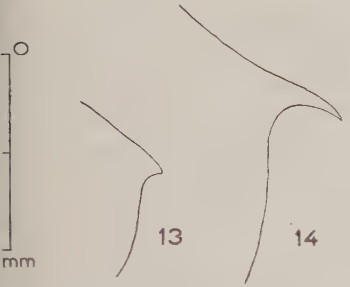
Uropodes (fig. 2). — Au *stade III,* le 6ème segment abdominal est disti du telson et porte une paire d'uropodes natatoires non segmentés. L'endopodi est représenté par un petit lobe glabre situé du côté interne, au quart proxim de l'article. Toute la partie antérieure à ce lobe représente l'exopodite. En arri de l'épine distale, sur le bord interne, sont insérées 6 longues soies plumeus longueur totale de l'article est sensiblement égale à celle du bord latéral du on.

Au *stade IV*, l'exopodite s'articule sur le basipodite; sa longueur représente les de la longueur totale de l'appendice et il porte 7 soies plumeuses sur son bord rne. L'endopodite, un peu plus développé, est toujours solidaire du basipodite porte 1 ou 2 soies dans la région distale.

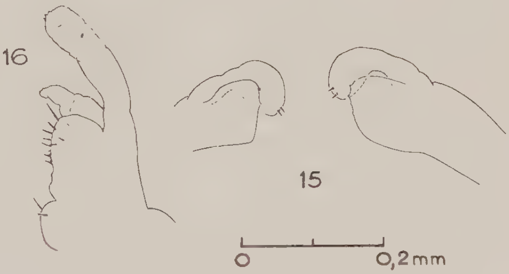
a coloration des zoés a été décrite par Pike et Williamson (1960, p. 522). Le omatophore près du bord ventro-latéral de la carapace fait défaut dans quelques cimens.

REMARQUES

Dans l'ensemble, le passage d'un stade à un autre au cours du développement traduit par des modifications relativement peu importantes des appendices. ce qui concerne les mandibules (Md), les 2 paires de machoires (Mx1 et Mx2) es 2 premières paires de maxillipèdes (Mxp1 et Mxp2), on note seulement un er accroissement de taille et une augmentation du nombre des soies à chaque e, sans différenciation de nouveaux articles. L'évolution des antennules (A1), antennes (A2) et de la 3ème paire de maxillipèdes (Mxp3) est plus marquée.



13-14. — Epine postéro-latérale de la carapace au stade IV: 13, *Catapaguroides timidus* (Roux); 14, *Anapagurus breviaculeatus* Fenizia.



15-16. — *Catapaguroides timidus* (Roux), glaucothoé: 15, mandibules; 16, premier maxillipède.

e fouet interne de A1, représenté par un bourgeon au stade I, s'allonge rapidet; il en est de même pour le fouet externe, qui s'articule au stade III; d'une sensorielle unique et distale au stade I, on passe progressivement à 3 groupes 2 à 3 de ces soies, insérées le long du bord interne de l'article, suivant une position qui annonce celle que l'on observe chez la glaucothoé et chez l'adulte. Tandis que l'écaille de A2 se modifie peu et porte un même nombre de soies ous les stades, l'endopodite s'accroît considérablement, perd ses deux soies meuses terminales au stade III et s'articule sur le basipodite au stade IV.

i Mxp1 et Mxp2 ne présentent que de faibles changements du stade I au stade Mxp3, à l'état de rudiment biarticulé, glabre, non fonctionnel, au stade I, se eloppe ensuite rapidement en un exopodite natatoire et un endopodite qui e non articulé et non fonctionnel, mais dont l'accroissement de taille est important.

Les appendices dont l'accroissement de taille est le plus rapide sont les pé podes. Non discernables au stade I, ils apparaissent au stade II comme de co ébauches. Ils s'allongent au stade III, et, au stade IV, ont acquis les dimens relatives et la forme d'ensemble qu'ils possèdent chez la glaucothoé. Ils son pendant encore insegmentés et ont l'aspect des régénérats que l'on observe che adultes, au stade qui précède la segmentation.

Les 4 paires de pléopodes apparaissent simultanément au stade IV, c'est-à- plus tardivement encore que les péréiopodes, sous forme d'ebauches biramées, pourvues de soies.

Enfin, les uropodes font leur apparition au stade III. Alors que Mxp3, pé podes et pléopodes passent par un stade d'indifférenciation, les uropodes semb d'emblée être fonctionnels; au stade III ce sont déjà deux grandes lames folia qui portent de longues soies plumeuses sur leur bord interne et ont une fonc natatoire: l'endopodite est représenté par un court lobe interne dans la ré proximale. Au stade IV l'allongement et le changement de forme de chaque ap dice sont peu accentués, mais une articulation les divise en une courte por proximale avec un lobe interne plus long qu'au stade III, l'endopodite, en solidaire du basipodite, et une longue lame distale, l'exopodite.

La comparaison entre la zoé IV et la glaucothoé décrite en 1958 (Dechan Forest, p. 277, fig. 1, 3-15 1)) fait ressortir des différences beaucoup plus c dérables qu'il n'en existe entre les stades zoé. Plus considérables aussi que c qui séparent la glaucothoé de la forme imaginale, de sorte que, si l'on peut p d'une métamorphose dans le cours du développement, c'est bien entre la zo et la glaucothoé qu'elle se situe.

Alors que les zoés mènent une vie pélagique, la glaucothoé rejoint le ben et va s'installer dans une coquille. Ce changement d'habitat s'accompagne d'im tantes modifications qui affectent en premier lieu la forme du corps. Par notamment du raccourcissement du rostre et du telson la longueur totale (po du rostre-bord postérieur du telson) passe de 3,6-3,9 mm à 2,3 mm envi Les péréiopodes p1 à p5, devenant fonctionnels, se déplacent vers l'avant et produit en même temps une sorte de télescopage des segments buccaux et tho ques antérieurs: les maxillipèdes, qui ont perdu toute fonction natatoire, et pièces buccales proprement dites se recouvrent étroitement.

Ces modifications, générales chez les Pagures, sont bien illustrées par les des d'une zoé IV et d'une glaucothoé de *Pagurus bernhardus* figurées de profil G. O. Sars (1889, pl. 2, fig. 16 et 29).

L'évolution des appendices qui étaient déjà différenciés chez la zoé IV se tra principalement par une augmentation du nombre des articles et des phanèr par l'apparition ou le développement de certaines régions, par exemple du palp mandibules (fig. 15), mais aussi par des régressions. Nous n'insisterons pas ici les profonds changements qui marquent le passage de la larve à la post-larve

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1) Nous n'avions pas eu la possibilité dans cette note de figurer les mandibules, et le Mxp présenté était mutilé: nous donnons ici des dessins de ces appendices (Md, fig. 15; Mxp1, fig.

timidus. Nous reviendrons, en effet, sur cette question dans un travail d'ensem-
sur le développement des Pagurides, mais nous noterons les régressions les plus
ortantes qui affectent certains appendices ou parties d'appendices:

L'exopodite de l'antenne, perdant tout rôle natatoire, se réduit à une très courte
ille; la mandibule perd ses dents cornées et se réduit à une très mince lame
ineuse; son palpe se développe, mais demeure insegmenté; l'endopodite des Mx1
présente plus trace d'articulation. Le Mxp1 se transforme par régression de
ndo- et de l'exopodite qui prennent un aspect indifférencié, sans segmentation
soies, alors que deux forts endites se sont développés; l'endopodite de Mxp2
serve sa segmentation mais devient beaucoup plus court que l'exopodite, tandis
, pour Mxp3, l'endopodite s'est segmenté en 5 articles bien développés dépas-
t largement l'exopodite.

ike et Williamson ont relevé certain des caractères généraux qui rapprochent
larves de *C. timidus* de celles des *Pagurus,* et les éloignent au contraire de
es des *Anapagurus:*

épines latérales du 5ème somite abdominal assez longues.

présence de 4 paires de pléopodes au stade IV, alors que la 4ème, ou la 3ème
et la 4ème manquent chez *Anapagurus*.

Ajoutons encore à ces deux caractères la forme de l'épine postéro-latérale de la
pace, courte chez *C. timidus* (fig. 13) comme chez les *Pagurus* [sauf, d'après
dessins de Mac Donald, Pike et Williamson (1957, pp. 221 et 227, fig. 2 et 4)
z *P. bernhardus* et *P. pubescens*), longue et aiguë chez les *Anapagurus* (fig. 14:
breviaculeatus]. D'autre part, à l'inverse des auteurs précités, nous avons ob-
é sur la mandibule, au stade IV, chez *C. timidus* et aussi chez *Pagurus ana-
retus,* le rudiment de palpe présent chez *P. bernhardus* et *P. pubescens,* et qui
défaut, toujours d'après les auteurs précités, chez *P. prideauxi, P. cuanensis,
latus.*

n ce qui concerne la présence d'une soie unique sur l'endopodite des uropodes
stade IV, qui rapprocherait les larves de *Catapaguroides timidus* de celles des
pagurus et de *Pagurus anachoretus,* nos observations ont montré que ce carac-
était variable: la plupart des zoés IV examinées portaient 2 soies, comme chez
autres *Pagurus* connus.

ous pensons que, faute de descriptions précises de tous les appendices chez
diverses espèces, il n'est guère possible de tenter un rapprochement, fondé sur
caractères larvaires, entre les genres de Pagurinae, d'autant plus que les *Pagurus*
stituent un groupe manifestement hétérogène.

a comparaison des dessins que nous donnons ici, avec ceux de M. T. Thompson
r *Pagurus longicarpus* (1903, pl. 5 et 6) et ceux de Mac Donald, Pike et Wil-
nson pour *Pagurus bernhardus* (1957, p. 222, fig. 3: antennule à maxille),
es figurations en série d'appendices de zoés de Pagures que nous connaissions,
ntre le parallélisme du développement de ces espèces, mais aussi des différences
s la structure à un stade donné et dans l'évolution des diverses parties de certains
endices.

Ainsi chez *Catapaguroides timidus,* l'endopodite de l'antenne, beaucoup p court que l'exopodite, non segmenté, pourvu de 2 longues soies dista au stade I, est nettement plus long que l'exopodite, articulé près de la base, et présente plus qu'une courte soie simple subdistale au stade IV. Chez *Pagu longicarpus* (Thompson, *loc. cit.*, pl. 5, fig. 8) l'évolution est semblable, à la férence que les dessins montrent l'endopodite articulé sur le basipodite dès le st I. Chez *Pagurus bernhardus* (Mac Donald, Pike et Williamson, *loc. cit.*, fig. 3 l'évolution est toute différente: au stade I, l'endopodite bien plus grêle, est d plus long que l'exopodite; il ne s'allonge que faiblement par rapport à ce dernier cours du développement, et, au stade IV, présente de nombreuses traces de s mentations (les auteurs n'indiquent pas qu'il est articulé à sa base); d'après dessins, il est glabre à tous les stades.

Autre différence, l'endopodite des maxillules compte très nettement 3 artic dès le stade I chez *Catapaguroides timidus,* de même que chez *Pagurus longicarp* alors que chez *Pagurus bernhardus* ,,. . . . the division between the 2nd and 3r incomplete . . . .'' (Mac Donald, Pike et Williamson, *loc. cit.*, p. 220) au stad et, d'après les dessins (*loc. cit.*, fig. 3 p-s), à tous les stades suivants.

Cet exemple montre l'intérêt qu'il y a à décrire et à figurer avec précision divers appendices aux différents stades. C'est seulement lorsque cette étude a été réalisée pour un assez grand nombre d'espèces appartenant aux différents ger que l'on pourra tenter un essai de classification des Pagurides, fondée sur caractères larvaires.

Nos dernières remarques concernent les différences que présentent nos zoé *Catapaguroides timidus* par rapport à celles de la baie de Naples récemment déc par Pike et Williamson *(loc. cit.*, p. 522):

— leur taille est légèrement inférieure.
— il y a 5 somites abdominaux visibles en vue dorsale au stade I et non 6.
— nous avons observé une épine anale, peu visible.
— l'écaille de l'antenne, au stade I, porte 10 soies, alors que Pike et William en notent 8.
— la mandibule, au stade IV, présente un rudiment de palpe.
— l'endopodite des uropodes, au stade IV, porte en général 2 soies.

Certaines de ces différences, notamment celle de taille, sont peut-être liées conditions hydrologiques différentes en baie de Naples et dans la région de B yuls-sur-Mer; elles pourraient aussi — mais ceci est peu probable — être d'or génotypique et dues à ce que les *Catapaguroides* de la baie de Naples appart draient à des formes distinctes. En fait, si Fenizia (1937, p. 3) a bien décrit cette région trois espèces et trois variétés nouvelles: *C. crassipes* et var. *tubercula* *C. acanthodes*, *C. macrochirus* et var. *platichelus*, et *C. timidus* var. *neapolitan* une telle fragmentation paraît injustifiée: l'on se trouve plutôt simplement, com le présume J. Forest, en présence d'une seule et même espèce, le *Catapaguroi timidus* de Roux, présentant de notables variations dont certaines très vraisem blement d'ordre phénotypique.

SUMMARY

e four larval stages (zoea I to zoea IV) of the Hermit Crab *Catapaguroides timidus* (Roux) are ibed. Detailed illustrations are given showing the changes which occur during development of appendage. The mandibles and the following appendages back to, and including, the second llipeds undergo only slight modifications of form and size from the first to the last stage. opods 1 to 5 appear at stage II, the uropods at stage III (at the same time as the telson becomes rentiated from the sixth abdominal segment), and the pleopods at stage IV.

portant changes in the form of the body and of the appendages occur at the moult from IV to the post-larva or glaucothoe, which is morphologically much nearer to the final or adult than to the zoeas.

far no complete descriptions, or detailed figures, of Pagurid larvae have been published; it is only possible to compare the development of a limited number of characters with those of species.

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SUR UN ISOPODE ASELLOTE DU GENRE *BAGATUS* RECUEILLI SUR POISSON DU SÉNÉGAL

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M. J. Cadenat a recueilli le 12 mars 1955 dans le vestibule branchial d'un son, *Antennarius* (*Fowlerichthys*) *senegalensis* Cadenat, 1959 (cf. Bull. I.F.A (A) 21, n° 1, 1959, p. 367) provenant des environs du Cap Rouge, Sénéga spécimens d'un Isopode appartenant à un groupe où aucun parasite n'est si et où les seuls commensaux connus vivent non sur des Poissons mais sur d'a Isopodes [1]).

A n'en pas douter, si ces échantillons avaient été trouvés sur les rayons d'un gère de musée, avec l'indication de pareille provenance, celle-ci se fût certaine vue discutée et rejetée pour invraisemblance: une nouvelle erreur d'étiquette, tant d'autres. Mais ici le doute est interdit et il faut admettre qu'il peut a à des Parasellidés de se rencontrer parfois dans les voies branchiales d'un culate. Présence purement accidentelle ou ayant quelque rapport avec la bi de l'espèce? Nous n'en saurions évidemment décider encore.

Les habitants de l'*Antennarius* appartiennent au genre *Bagatus* Nobili, 19 paraissent représenter une espèce nouvelle.

La systématique des espèces du genre *Bagatus* demeure, R. Amar l'a utile rappelé (1950, p. 41), confuse.

Les espèces actuellement comprises dans le genre paraissent être les suiva

1. *Bagatus stylodactylus* Nobili, 1906

1906 — *Bagatus stylodactylus* Nobili, p. 268.
1907 — *Bagatus stylodactylus* Nobili, p. 418, pl. 2, fig. 11-11*a*.
1910 — *Janira Crosslandi* Stebbing, p. 225-226, pl. 22, fig. A.
1933 — *Bagatus stylodactylus* Monod, p. 169, fig. 69 (1-2)-70 (1-2).
1946 — *Bagatus stylodactylus* Nordenstam, p. 15-16, fig. 12-14.
1950 — *Bagatus stylodactylus* Amar, p. 36, 41.

Hab. — Polynésie, Iles Gilbert et Ellice, Mer Rouge.

2. *Bagatus nanus* (Stebbing, 1905) Monod, 1933

1905 — *Janira* (?) *nana* Stebbing, p. 50, pl. XIII, fig. C.
1910*a* — *J.*[*anira*] *nana* Stebbing, p. 109, 110.

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[1]) Ou sur une Méduse, cf. p. 76.

1933 — *Bagatus nanus* Monod, p. 169-170.
1946 — *Bagatus nanus* Nordenstam, p. 18.
Hab. — Ceylan.

Bagatus minutus (Richardson, 1902) Nordenstam, 1946
1902 — *Janira minuta* Richardson, p. 297, pl. XXXIX, fig. 50-52.
1905 — *Janira minuta* Richardson, p. 471-472, fig. 525 *a-c*.
1910*a* — *Janira minuta* Stebbing, p. 109, 110.
1941 — *Janira minuta* Miller, p. 319.
1946 — *Bagatus minutus* [incl. *B. Stebbingi*] Nordenstam, p. 15.
Hab. — Bermudes, Castle Harbor, "in dead coral".

Bagatus stebbingi Monod, 1933
1910*a* — *Janira Crosslandi* Stebbing, p. 108-110, pl. 6, fig. A.
1914 — *Janira minuta* Vanhöffen, *pro parte*: p. 528, fig. 56 *a*.
1931 — *Janira Crosslandi* Monod, p. 408-410, fig. 9 (1-3).
1933 — *Bagatus Stebbingi* Monod, p. 170, fig. 71 (1-5).
1946 — *Bagatus minutus* Nordenstam, p. 15.
1950 — *Bagatus Stebbingi* Amar, p. 36, 40, 41.
Hab. — Seychelles, Syrie, env. Açores (Sargasses).

Bagatus stebbingi Monod var. *galloprovincialis* Amar, 1950
1950 — *Bagatus Stebbingi* Monod var. *galloprovincialis* Amar, p. 36-41, [16] fig.

Bagatus platydactylus Nobili, 1906
1906 — *Bagatus platydactylus* Nobili, p. 268.
1907 — *Bagatus platydactylus* Nobili, p. 418-419, pl. 3, fig. 6-6 *a-b*.
1933 — *Bagatus curvidactylus* [laps. cal.] Monod, p. 169.
1933 — *Bagatus platydactylus* Monod, p. 170.
Hab. — Polynésie.

Bagatus longidactylus Nordenstam, 1946
1946 — *Bagatus longidactylus* Nordenstam, p. 16-18, fig. 15-19 2)
Hab. — Iles Gilbert.

Bagatus longimanus Pillai, 1954
1954 — *Bagatus longimanus* Pillai, p. 19.
Hab. — Travancore.

emarques — Le Dr. Pillai a bien voulu me communiquer un calque des ex-
nts dessins qu'il doit publier. L'espèce appartient au groupe des *Bagatus* à
ode très allongé (*B. nanus*, *B. longidactylus*); par ses 2 dents propodiales il
pproche tout particulièrement de *B. longidactylus* et, n'était la forme apparem-
plus élargie de la partie proximale des pléopodes 1, ♂, on serait tenté de
dérer les *B. longimanus* et *longidactylus* comme conspécifiques.

La „main" du pér. 1, ♂ est un carpe (et non un propode), le „doigt" un propode (+ un tout dactyle) et non un „very long dactylus".

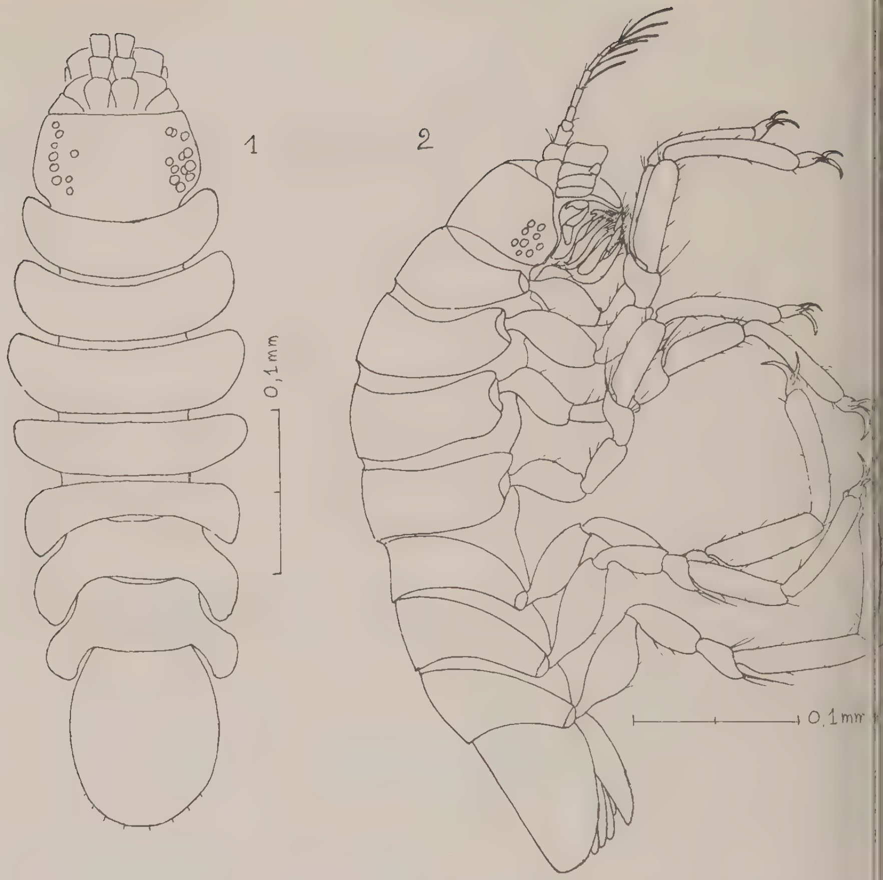


Fig. 1-2. *Bagatus ichthyoxenos* n. sp. — 1, vue dorsale (sans uropodes); 2, ♀ non ovig., vue l
(sans uropodes).

8. *Bagatus algicola* (Miller, 1941) Pillai, 1954

1941 — *Janira algicola* Miller, p. 317-319, fig. 4.

Hab. — Iles Hawaii.

Remarques — C'est Pillai (1954, p. 19) qui a proposé de placer cette
dans le genre *Bagatus* à très juste titre d'ailleurs.

9. **Bagatus ichthyoxenos** nov. sp.

? 1914 — *Janira minuta* Vanhöffen, *pro parte,* p. 528-529, fig. 56 *b.*
? 1949 — *Janira* sp. Brian et Dartevelle, p. 93-94, fig. 8-10.

Description. — Corps (fig. 1-2) allongé, environ 3 fois plus lon
large, relativement convexe, inerme, glabre.

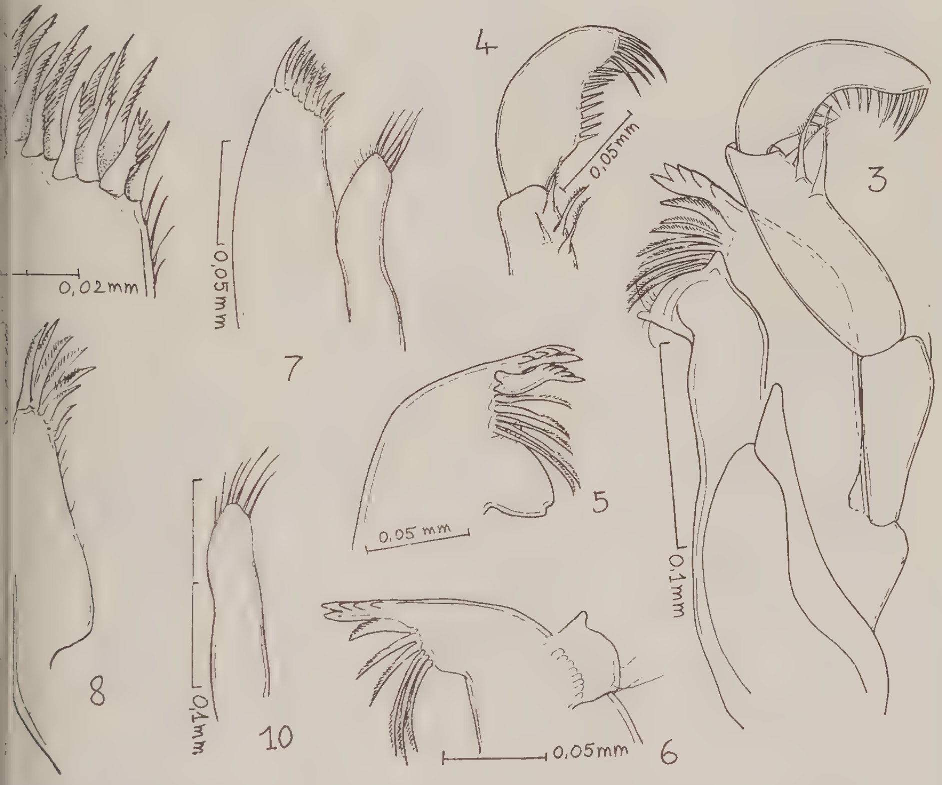
Tête $1^2/_3$ fois plus large que longue, à bords latéraux convexes, à bord f
transversal.

eux très réduits, non pigmentés, limités à un petit nombre d'éléments (p. ex.
. 12).

éréionites libres à bords latéraux arrondis, plus ou moins recourbés vers l'avant
) ou vers l'arrière (5-7). Ni épines ni soies.

léon ovoïde, légèrement plus long que large, arrondi au bord postérieur qui
e quelques très petites épines.

ntennules (fig. 34): articles pédonculaires de volume et de longueur décrois-
e; flagellum 9/10-articulé, avec une lanière sensorielle sur chaque article à
ir du 3e.



3-10. *Bagatus ichthyoxenos* n. sp. — 3, mandibule droite; 4, extrémité du palpe mandibulaire;
trémité de la mandibule gauche; 6, *id.*, droite; 7, maxillule; 8, *id.*, lame externe; 9. *id.*, extrémité distale de la lame externe; 10, lame interne.

ntennes (fig. 34): aucun spécimen n'a conservé de ses antennes plus que
pédoncule, qui est très court, n'atteignant pas l'extrémité du pédoncule A 1;
le très petite.

Iandibule (fig. 3-6) avec une *pars incisiva* 5-dentée; une *lacinia mobilis* (à
he) ressemblant, en dimensions et en armature, à la *pars incisiva*; une rangée
-8 soies pectinées et une *pars molaris* bien développée.

Iaxillule (fig. 7-10) lobe externe à une dizaine d'épines pectinées

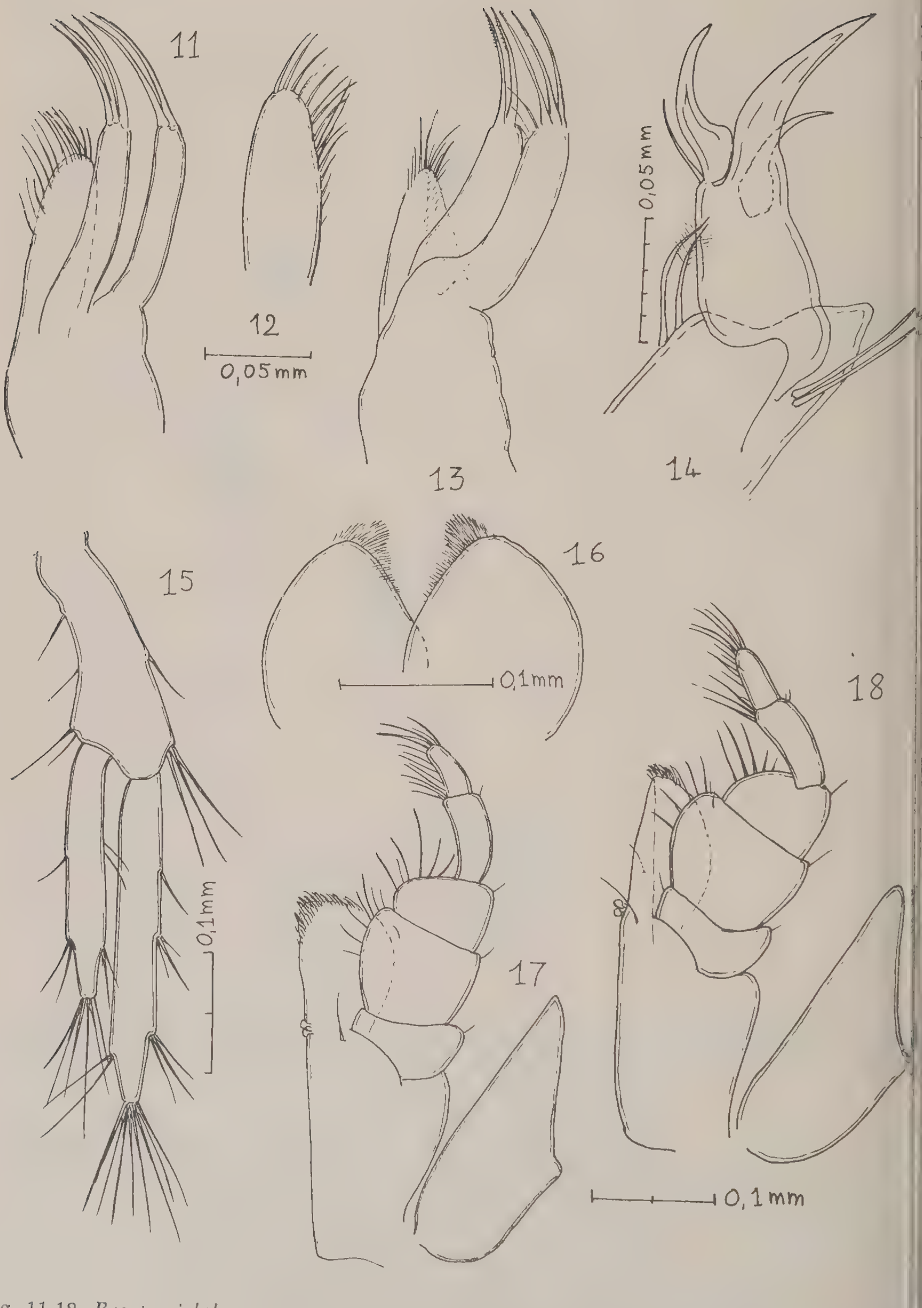
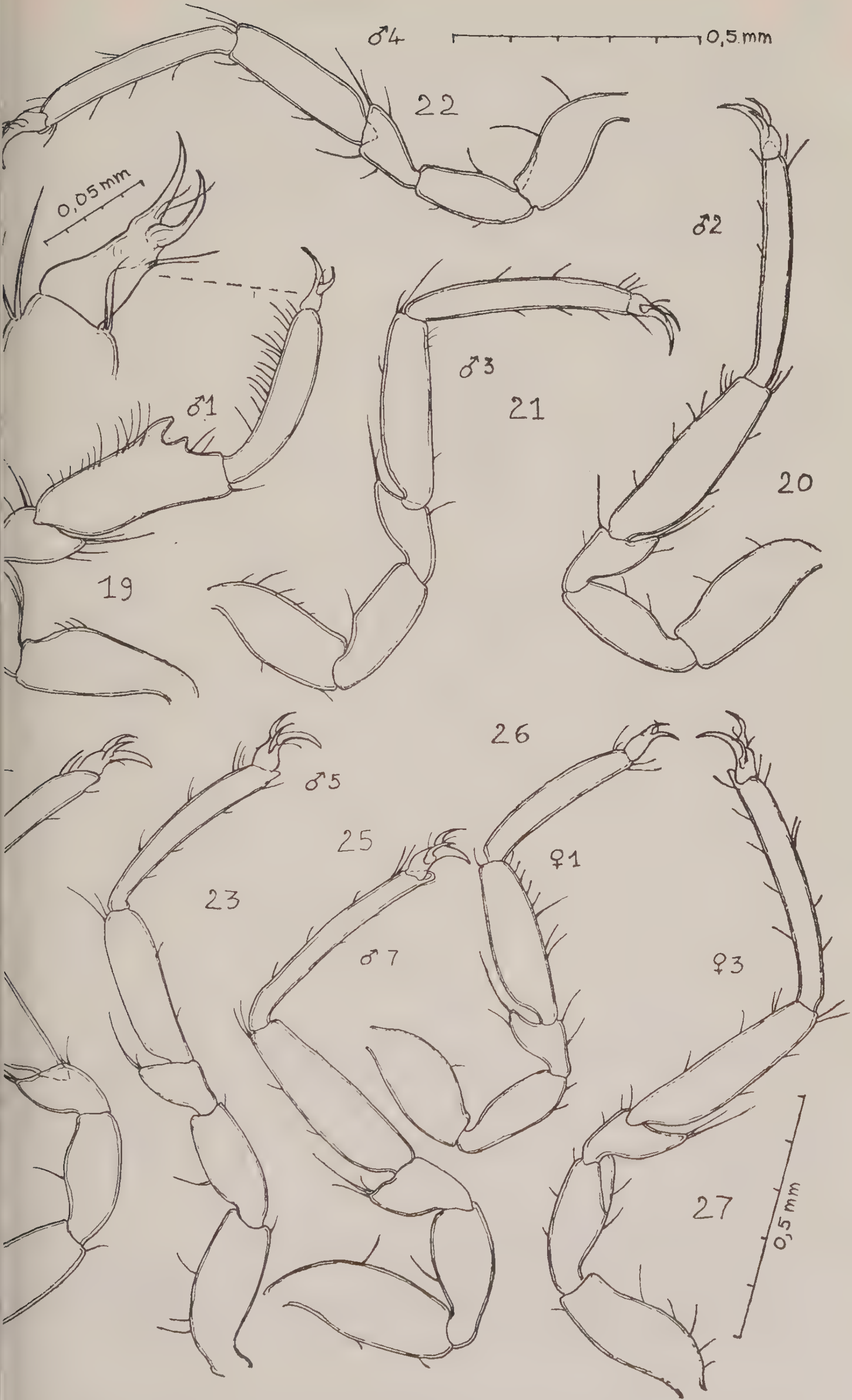

11
12
0,05 mm
13
14
0,05 mm
15
0,1 mm
16
0,1 mm
17
18
0,1 mm

Fig. 11-18. *Bagatus ichthyoxenos* n. sp. — 11, maxille; 12, *id.*, lame interne; 13, *id.*; 14, griffe 5e péréiopode, ♀; 15, uropodes; 16, hypostome; 17, maxillipède; 18, *id.*, mais avec le lobe inte partiellement replié.


♂4
0,5 mm
22
♂2
0,05 mm
♂3
21
♂1
20
19
26
♂5
25
♀1
23
♂7
♀3
27
0,5 mm

19-27. *Bagatus ichthyoxenos* n. sp. — 19, péréiopode 1, ♂; 20, pér. 2, ♂; 21, pér. 3, ♂;
pér. 4, ♂; 23, pér. 5, ♂; 24, pér. 6, ♂; 25, pér. 7, ♂; 26, pér. 1, ♀; 27, pér. 3, ♀

Maxille (fig. 10-13) à lobes externes très étroits.

Maxillipède (fig. 17-18): article 2 (sans son lobe interne, arrondi) plus c que le palpe dont les 3 premiers articles sont fortement dilatés et les 2 dern cylindroïdes; épipodite à bord distal externe légèrement concave.

Péréiopodes 1, ♂ (fig. 19) avec le carpus dilaté et portant 2 dents au inférieur; 2 griffes aux P 1, ♂ et ♀, 3 aux P 2-7, de tailles inégales (fig. 14 et Pour la forme des péréiopodes, cf. fig. 19-31.

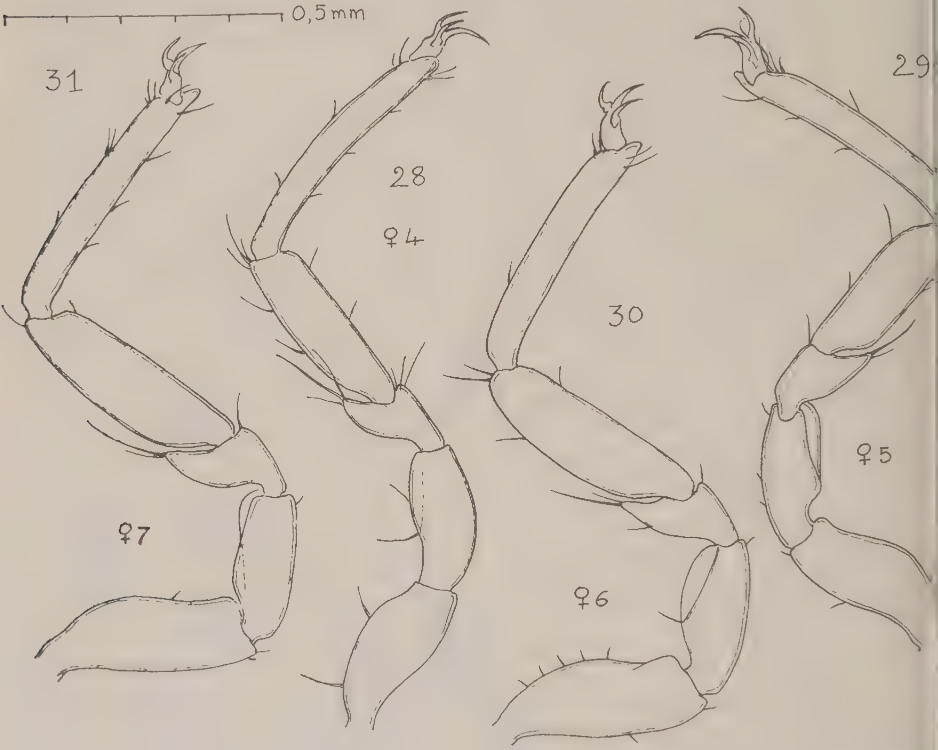


Fig. 28-31. *Bagatus ichthyoxenos* n. sp. — 28, péreiopode 4, ♀; 29, pér. 5, ♀; 30, pér. 6
31, pér. 7, ♀.

Operculum ♀ (fig. 35) arrondi, à bord postérieur très légèrement échancré.

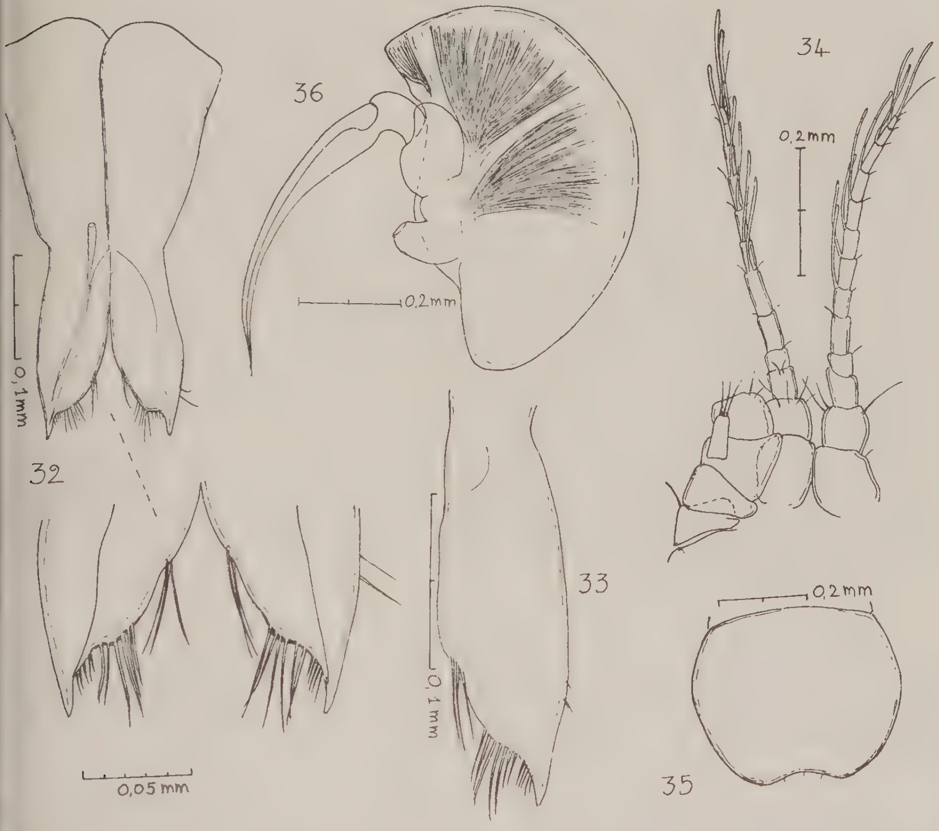
Operculum ♂ (fig. 32-33 et 36) avec lame médiane à extrémité obliquem étirée en pointe saillante précédée d'un petit sinus interne setifère; la pl latérale à bord externe régulièrement arrondi, à bord interne légèrement sinu articles 1 et 2 très courts, appareil copulateur très effilé, aussi long que la pla latérale.

Taille — 2-2,5 mm.

Hab. — 13 spécimens (3 ♂, 3 ♀, ov., 1 ♀ juv., 5 juv. + 1 ex.).

Remarques. — Le genre *Bagatus* est encore très imparfaitement conn plusieurs des espèces de la liste donnée plus haut demeurent des *species inquiren* (*B. nanus, B. minutus* p. ex.).

Nordenstam (1946, p. 15) est d'avis que *Janira minuta* Richardson et *Bagatus bbingi* Monod sont synonymes, l'espèce devant se nommer *Bagatus minutus.* l'on songe que les pl 1, ♂ de *Janira minuta* sont inconnus, on hésitera sans doute admettre cette conclusion, d'autant plus que si la figure du p 1 ♂ de *minuta* Richardson, 1905, fig. 525 *c*) est exacte, les 3 dents du bord distal-interne du 1, ♂ ne sont pas du tout disposées comme chez *stebbingi*; il semble préférable tenir *minuta* pour une espèce douteuse, jusqu'à ce que les pléopodes ♂ aient être décrits.



g. 32-36. *Bagatus ichthyoxenos* n. sp. — 32, pléopodes 1, ♂; 33, pl. 1, ♂; 34, antennules; 35, opercule, ♀; 36, pléopode 2, ♂.

Amar (1950, p. 41) a très justement noté que Vanhöffen (1914) paraissait oir réuni, sous le nom de *"Janira minuta* Richardson", deux *Bagatus* dont l'un arages des Açores) pouvait être le *stebbingi,* celui des Iles du Cap Vert se rapochant de *stylodactylus.* La forme des Açores est à peu près certainement *steb-ngi,* à en juger par la forme de l'extrémité des pl. 1, ♂; quant à celle des Iles du p Vert, le seul élément de comparaison avec *stylodactylus* est fourni par les pl. ♂. Si l'on rapproche la figure de Vanhöffen (1914, fig. 56 *b*) avec la mienne

(1933, fig. 70/1) on hésitera à admettre l'identité des deux espèces; il y a sa doute une certaine ressemblance dans le dessin général de l'extrémité, mais le dét (caractère des pointes et chétotaxie) diffère à mon avis suffisamment pour que l' hésite à tenir pour synonymes deux espèces dont l'une est d'ailleurs indo-pacifiq et l'autre atlantique.

Par contre, je pense que les 2 échantillons cap-verdiens de Vanhöffen et n spécimens sénégalais sont conspécifiques. Sans doute l'extrémité du pl 1, ♂ figur par Vanhöffen présente-t-elle des angles étirés en pointes particulièrement aigu davantage même que ne le représente ma fig. 32: on peut cependant admettre possibilité d'une certaine variabilité de ce caractère car si les angles peuvent êt *moins* étirés (fig. 33) pourquoi ne pourraient ils l'être *davantage* (Vanhöffe 1914, fig. 56*b*)? Le dessin de Vanhöffen n'est pas aussi précis qu'on l'eût souhait mais on y note cependant une division des soies internes en 2 groupes séparés par u diastème, souligné même par une légère encoche du contour. Les spécimens sénég lais examinés ont aussi des soies divisées en deux groupes principaux: un proxim [A] (3 soies assez longues) et, après un diastème (sans encoche), un distal, lu même composé d'une première série [B] (de 6-7 soies assez longues) et d'une s conde [C] (d'env. 5 petites soies). Sans doute y-a-t-il, dans le dessin du bord int ne des apex de légères variations, concernant le développement du lobe, plus moins marqué, portant le groupe B de soies et, corrélativement, sur la profonde du sinus séparant le groupe B de l'apex (et portant le groupe C), mais on n'obser pas le lobe semi-circulaire saillant du *B. stebbingi*.

Il n'est pas impossible que le *Janira* sp. cité par Brian et Dartevelle de Landa Congo, sur la Méduse *Catostylus tagi* (Haeckel), appartienne aussi à la précéder espèce; le spécimen congolais est malheureusement juvénile (1,4 mm) et présen peu de caractères utilisables.

SUMMARY

An Isopod belonging to the genus *Bagatus* and apparently representing a new species has be found in the branchial cavity of a Pediculate Fish on the west coast of Africa (Senegal). A descr tion is given of *Bagatus ichthyoxenos* n. sp., together with a tentative check-list for the known spec of the genus.

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Reçu: le 18 juillet 1960.

NOTES AND NEWS

NEW RECORDS FOR TWO DEEP-SEA DECAPODS

BY

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Research in Dairying, Shinfield, Reading, England.

Among the many deep-sea crustaceans recently sorted for our biochemical wo we have identified two species, taken in hauls made at positions well outside th previously recorded ranges. The identifications were very kindly confirmed by D Isabella Gordon, British Museum (Natural History).

The first of these is a pasiphaeid *Eupasiphaë gilesi* Wood-Mason originally scribed from the Indian Ocean in the vicinity of the Andaman Islands by Wo Mason and Alcock (1893) and figured by Wood-Mason (1892). Alcock (18 subsequently recorded the species off the Goa coast on the west side of India a in the Arabian Sea north of the Laccadive Islands (Alcock, 1901). Our specim was taken in an oblique haul from 800 m to the surface by the Isaacs-Kidd m water trawl on 5 April 1958 in the vicinity of Madeira at 32°20′N-16°38′ sounding 3025 m, during a cruise of R.R.S. "Discovery II" and so is the fi record for this species in the Atlantic Ocean. It is a female with overall len from tip of rostrum to tip of telson, 60 mm; carapace length, 19 mm; anten scale, 8 mm; abdomen, 41 mm; 6th abdominal somite, 7 mm; and telson 10 m Unlike that in the specimen of Wood-Mason and Alcock, the telson is compl and the tip has a large spine at the distal end of each outer margin with six smal spines between them just as in *Parapasiphaë sulcatifrons* Smith. The proportions the carapace length to the total length differ somewhat from those given by Woo Mason and Alcock, but this may be due to the loss of some of the telson in th specimen. Otherwise it corresponds in every respect to the description of the Ind Ocean specimen, much more so than did Chace's (1940) *Parapasiphaë* sp. *b* fr Bermudan waters, which he believed to resemble *E. gilesi*.

In December 1956 we received from Mr. G. E. Maul of the Museu Munici do Funchal, Madeira, a number of decapod crustaceans taken from stomachs of scabbard-fish *Aphanopus carbo* caught on long lines by local fishermen. Among them were three specimens which we identified as *E. gilesi* but these were used f biochemical work before we realised that they had not previously been record

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[1]) Grant-aided by the Development Fund.

he Atlantic. We were, therefore, gratified to receive the fresh specimen de-
ed above from the same sea area to confirm the earlier identification.

he second species is an oplophorid *Systellaspis cristata* (Faxon), already known
iously from the Pacific (Faxon, 1893, 1895), Indian (Alcock & Anderson,
6; Anderson, 1896; Alcock, 1899, 1901; de Man, 1920; Balss, 1925) and At-
ic (Balss, 1925; Holthuis, 1951; Springer & Bullis, 1956; Figueira, 1957) O-
ıs. None of these earlier specimens was taken at a latitude higher than those re-
ly reported by Figueira (1957) from stomachs of *Aphanopus carbo* caught in
leiran waters at about 33°N. The specimen we identified was taken in an Isaacs-
d mid-water trawl hauled obliquely to the surface after veering 3300 m of warp
18 October 1959 at a position in the Bay of Biscay between 43°51′N-3°55′W
44°04′N-3°39′W. It had a total length of 53 mm, carapace (including ros-
ı) 18 mm, rostrum 7 mm, and antennal scale 7 mm, and agrees in every res-
with the specimens described by Holthuis and Figueira rather than with those
axon.

oth specimens have been deposited at the British Museum (Natural History).

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A NOTE ON CROSS-BREEDING BETWEEN *CARIDINA WEBERI* VA *SUMATRENSIS* AND *C. RAJADHARI*

BY

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Caridina weberi var. *sumatrensis* de Man and *Caridina rajadhari* Bouvier two species of freshwater prawns found in different localities around Bombay female of *C. weberi* var. *sumatrensis,* having a mature ovary which was ea discernible through the exo-skeleton, was kept in a glass trough with a ma male of *C. rajadhari.* On the third day, the female was found to have mou and the eggs were neither in the ovary nor on the pleopods, indicating that t were shed, probably because copulation had not taken place. A next batch of e was seen in the ovary about 15 days after moulting but even this batch was s without having been fertilized. The third batch was ready again after abou fortnight and this time the eggs were found to be attached to the pleopods of female, where they remained only for five days, after which, owing to fai of further growth, they were shed off. The fourth batch of eggs was seen atta to the pleopods after about two weeks. The eggs hatched out on the eleventh giving in all 382 larvae in the protozoea stage. This rate of embryonic develop was somewhat slower than the normal period of 8 to 9 days of larval hatchin either of the two species when bred separately.

The newly hatched larvae as a result of cross-breeding were of the size of t of *C. rajadhari* and little smaller than those of *C. weberi* var. *sumatrensis.* differed from the larvae of the parent species in the details of the armature o telson. The posterior margin of the telson bears minute spinules between innermost and the outermost spines in *C. weberi* var. *sumatrensis* and between third and the outermost in *C. rajadhari,* while such spinules were found betw the fourth and the sixth spines on the telson of the hybrid larvae. The larvae sho more resemblance in general form to those of *C. rajadhari* than to those o *weberi* var. *sumatrensis.*

Enquiries were made to Dr. L. B. Holthuis of the Leiden Museum and to D Gordon of the British Museum about any previous notes on cross-breeding amo decapod crustacea. They have communicated that to their knowledge there so far, been no record of cross-breeding in decapod crustacea and this re therefore, forms the first successful attempt of this kind.

The author is grateful to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State, a Dr. H. G. Kewalramani, Research Officer, for their valuable guidance and encouragement.

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SERVATIONS ON *MICROPROSTHEMA SEMILAEVE* (VON MARTENS) (DECAPODA, STENOPODIDAE) FROM FLORIDA

BY

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tenopodidean shrimps are among the most highly colored members of the stacea Macrura. *Microprosthema semilaeve* is a small stenopodidean known n scattered areas in the western Atlantic from the Bahamas to Fernando No- ha (Holthuis, 1946). It has not previously been recorded from Florida. Holt- (op. cit.) noted that the living color had not been observed.

small specimen was collected by the author at Long Reef, a dead coral reef the upper Florida Keys in June of 1960. The specimen was kept alive and ed in an aquarium at The Marine Laboratory for observation. Some notes on aviour and a complete color description of the animal were obtained.

olor. Background color brilliant red, with patterns of white and colorless areas the dorsal surface. Antennular flagellum red basally, banded with red and r areas in the median portion, colorless distally. Antennular peduncle blotched and white, clear in its proximal half. Scaphocerite red laterally, anteriorly rless; inner, setose margin colorless except for an indistinct patch of pink. ennular peduncle red, antennae colored as antennules.

yestalks blotched red and white, cornea rimmed with red. Stalk with anterior posterior colorless areas separated by a red line.

ostrum colorless anteriorly and ventrally. Dorsal margin, including posterior spines, deep red; anterior spine in colorless area.

arapace primarily red, with four paired white spots on dorsal surface; one pair ase of rostrum, another, smaller pair lateral to these posterior to scaphocerite, ird pair in front of the cervical groove, and a pair near the posterior margin. tral and posterolateral margins of carapace white. Carapace with reticulate ern of red and colorless areas dorsally. Most of the dorsal surface is colorless, le the lateral surfaces are largely red.

ll chelipeds are brilliant red, except for white tips of claws. The walking legs primarily red. The ischium is white proximally, red distally. The merus is pletely red; while the carpus is colorless proximally, red distally. The distal ion of the carpus and propodus have a lateral clear stripe and a pronounced al and ventral longitudinal stripe of red. The dactylus is colorless, the bases of he walking legs are white.

irst abdominal somite with a large white median dorsal patch. Second ab- inal somite also with a dorsal white patch, larger, with a colorless area posterior is on the dorsal margin. Four white spots on the third and fourth abdominal ites form a diamond pattern, through which runs a broad, diffuse, transverse

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Contribution No. 284 from The Marine Laboratory, University of Miami, Miami, Florida.

red band. Three of the four spots are on the third somite, one anterior, on midline, two posterior, off the midline. The largest of the four spots is on fourth somite. A broad band of red crosses the abdomen at the posterior mar of the fourth and fifth somites. The pleurae of all the somites are red.

Telson with a median longitudinal streak of white, lateral borders red, se of telson and uropods, white.

This striking color pattern camouflages the animal quite well in its habitat the coral reef. It blends in completely with coral rocks encrusted with red fo minifera and coralline algae.

Observations on the animal. In life, the body is strongly flexed at the junct of the carapace and abdomen, and the telson and uropods are folded under body. The upper antennular flagellum is held upward and backward, while lower antennular flagellum extends forward and outward. The long anten are directed laterally, and the anterior setae of the scaphocerite meet anterio The major chelipeds are held outward from the body.

When dislodged from its hiding place, the small shrimp scuttles sideways the nearest rock or clump of weed. Usually it pauses for a brief moment, appare to inspect the rock, then it turns and crawls under the rock backwards and ups down. It remains in this inverted position, facing outwards.

While in the aquarium, the shrimp passed through one molt. A regenera claw doubled in size during the molt. The shed skin of the animal was recove and was intact except for the carapace, which was dislodged. In order to extri the large major cheliped, the shell of the remaining segments fractures long dinally along the anterior and posterior margin; the propodus does not fract Some measurements of the molt and the living specimen are given below.

Measurements. Molt. Scaphocerite length, 1.3 mm; major chela, carpus len 2.3 mm, propodus length, 2.2 mm; telson length, 1.6 mm.

Live animal. Carapace length (including rostrum), 4.1 mm; scaphocerite len 1.6 mm; major chela, carpus length, 2.5 mm, propodus length, 2.6 mm.

Remarks. In addition to the material from Long Reef, there are specimens *M. semilaeve* from Biscayne Bay (UMML 32.989) and Long Key, Tortu (UMML 32.348), Florida, in the collections of The Marine Laboratory. Altho it has not previously been recorded from Florida, its occurrence in three wi separated areas indicate that it may be fairly common on the reefs.

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REVIEW

RECENT WORK ON MARINE BORING ORGANISMS

) "The marine borer family Limnoriidae (Crustacea, Isopoda)". R. J. Menzies
Bull. Mar. Sci. Gulf and Caribbean 7 (2): 101-200, text-figs. 1-42, 1957.
ce $ 2.00.

i) "Marine Boring and Fouling Organisms". Edited by D. L. Ray. Seattle.
iversity of Washington Press. 536 pp., illustrated. 1959. Price $ 8.50.

A symposium on Marine Boring and Fouling Organisms was held at Friday
rbor in September, 1957, and the papers then delivered orally are now made
ilable to a wider audience under five headings: Limnoria; Terediniens; Barna-
; Cellulases; Economic Implications and Evaluation. The book (Ray, 1959)
vell illustrated and produced and, as each paper has an up-to-date bibliography,
uld prove useful to biologists, biochemists and industrialists alike. Since certain
ions are outside the province of Crustaceana, this review will deal chiefly with
Limnorias.

wo groups of boring organisms are mainly responsible for damage to sub-
rged structures namely, the Teredos or shipworms (Mollusca) and the Lim-
ias or gribbles (Crustacea, Isopoda). Before the last war the main emphasis
on shipworm control; but, with the extensive adoption of pressure creosoting of
ine piling, damage due to Teredos seems to have decreased while that due to
noria has increased. In recent years, therefore, much attention has been paid
hese minute Isopoda, with rather surprising results. Before the war only six
cies of *Limnoria* were known, four of which attack wood and two attack lami-
an seaweeds. Menzies' (1957) recent study of the systematics and geographical
ribution of the family Limnoriidae includes no fewer than 22 species, 15 of
ch are xylophagous, and two wood boring species have been added since then.
new genus has been established for a tropical species, *Paralimnoria andrewsi*
lman). The genus *Limnoria* is divided into two subgenera, (*Limnoria*) for
wood borers and (*Phycolimnoria*) for those that attack seaweeds. *Limnoria*
) *lignorum*, "the gribble", hitherto regarded as a cosmopolitan species, proves
ave a restricted boreal range; other species are temperate, temperate-tropical,
ropical. In addition to *lignorum*, three wood boring species occur in European
ers, namely, *L.* (*L.*) *quadripunctata* Holthuis, 1949, *L.* (*L.*) *tripunctata* Men-
, 1951, and *L.* (*L.*) *carinata* Menzies and Becker, 1957. Since the ornamentation
the telson and fifth abdominal somite affords good specific characters, speci-
s should not be preserved in formalin or any solution that is, or may become,
; 75% ethyl alcohol is recommended.

In the later work (Ray, 1959) the section on *Limnoria* has a useful illustra
key by Menzies to the 22 species dealt with in his earlier monograph, a series
drawings showing the morphological characters of taxonomic value, and dis
bution maps. Becker gives an account of biological investigations on marine bor
conducted over a period of years, at the Berlin-Dahlem laboratory, where a M
terranean species of *Limnoria* has been successfully reared through many gene
tions at 20°C. Recent work by various American investigators on the histolo
cytology, nutritional physiology and protozoan associates of *Limnoria* is summ
rised. No bacteria or Protozoa have been found in the gut of *Limnoria*; gribb
cannot live for long on a diet of fungi alone although they, like Teredos, can
attack fungus-free wood. Dr. Ray has proved that they are capable of produc
their own cellulolytic enzymes and, in spite of the practical difficulties invol
has made a preliminary study of the properties of cellulase from *Limnoria*.

The section on barnacles deals with the distribution of the *amphitrite* series
Balanus in North American waters; the feeding, moulting and growth of *Bala*
eburneus reared in the laboratory; and with certain aspects of extensive studies
Balanus balanoides (L.) recently carried out at Millport.

I.G

A NEW JAPANESE BATHYNELLID

BY

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Allobathynella mirabilis sp. nov.

his is the second species of the genus *Allobathynella* Morimoto et Miura
7), and in its general appearance it resembles more closely the species of
nella than those of *Parabathynella*. Although only the male is obtained, it
rs from the type species of the genus, *A. japonica* Morimoto et Miura, in
al features. In the present species, the exopodites are 5-segmented in the
o 7th pairs of pereiopods, while those of *A. japonica* are composed of 4 seg-
s. Each furcal lobe of the telson of the present species is armed with 6
s arranged in two series, but that of *A. japonica* has 5 spines. The basipo-
of the uropods differ in the number of spines, *A. mirabilis* having a row
spines, whereas there are only 5-6 spines in *A. japonica*. The endopodites of
ropods of the present species have 6 spines in two series, but in *A. japonica*
are 4 or 5 spines, which become successively longer towards the apex. Finally,
e present species most of the somites are distinctly carinated, while in *A.*
ica a carina does not develop on any somite.

scription of the male. — Body cylindrical, somewhat compressed laterally,
es well-defined, first two thoracic somites markedly shorter than the suc-
ng ones, which become distinctly longer towards the rear; from the fifth
cic to the last abdominal somites carinated; cuticle slightly calcified, surface
ly covered with minute punctuation. Length of body: 2.0 mm.

ad large, a little longer than the first three somites together, narrowed
ds the front; eyes entirely absent. Antennules longer than head, composed
segments, with 1-segmented endopodite on the 3rd basal segment. Antennae
er than antennules, recurved behind, consisting of 5 segments. Mouth-parts
developed. Labrum large, provided with 15 small teeth on the frontal mar-
Mandibles slender, terminating in 4 blunt teeth, molar plate large, armed
9 short spines; mandibular palp 1-segmented, terminal seta not extending
d the apex of the mandible. Maxillulae large, extending beyond the apex
andibles in the natural state; with 2 endites, the proximal terminating in
ae, and the distal slender, ending in a large spine at the apex, and with 5
s in two groups on the inner margin. Maxillae markedly slender, shorter
maxillulae, with 3 endites, the proximal two tipped with 2 and 3 setae

respectively, the distal one armed with 5-6 setae around the apex and 2-3
on the outer side.

Pereiopods 1 to 7 all of biramous construction; endopodites of all 7 pairs
sisting of 4 segments, but exopodites 5-segmented in the 4th to 7th pair
segmented in the 1st and 4-segmented in the 2nd and 3rd pairs. A single
developed epipodite present on the base of pereiopods 4 to 6, but absent o
1st to 3rd and 7th pairs respectively. The 8th pereiopods markedly red
round in form, bearing a minute endopodite tipped with 2 short setae. One

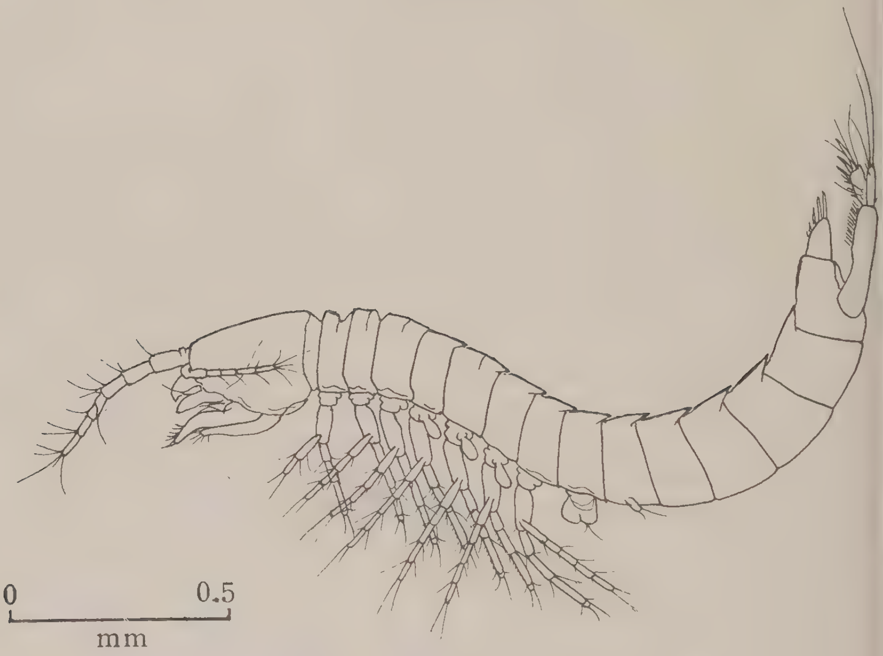
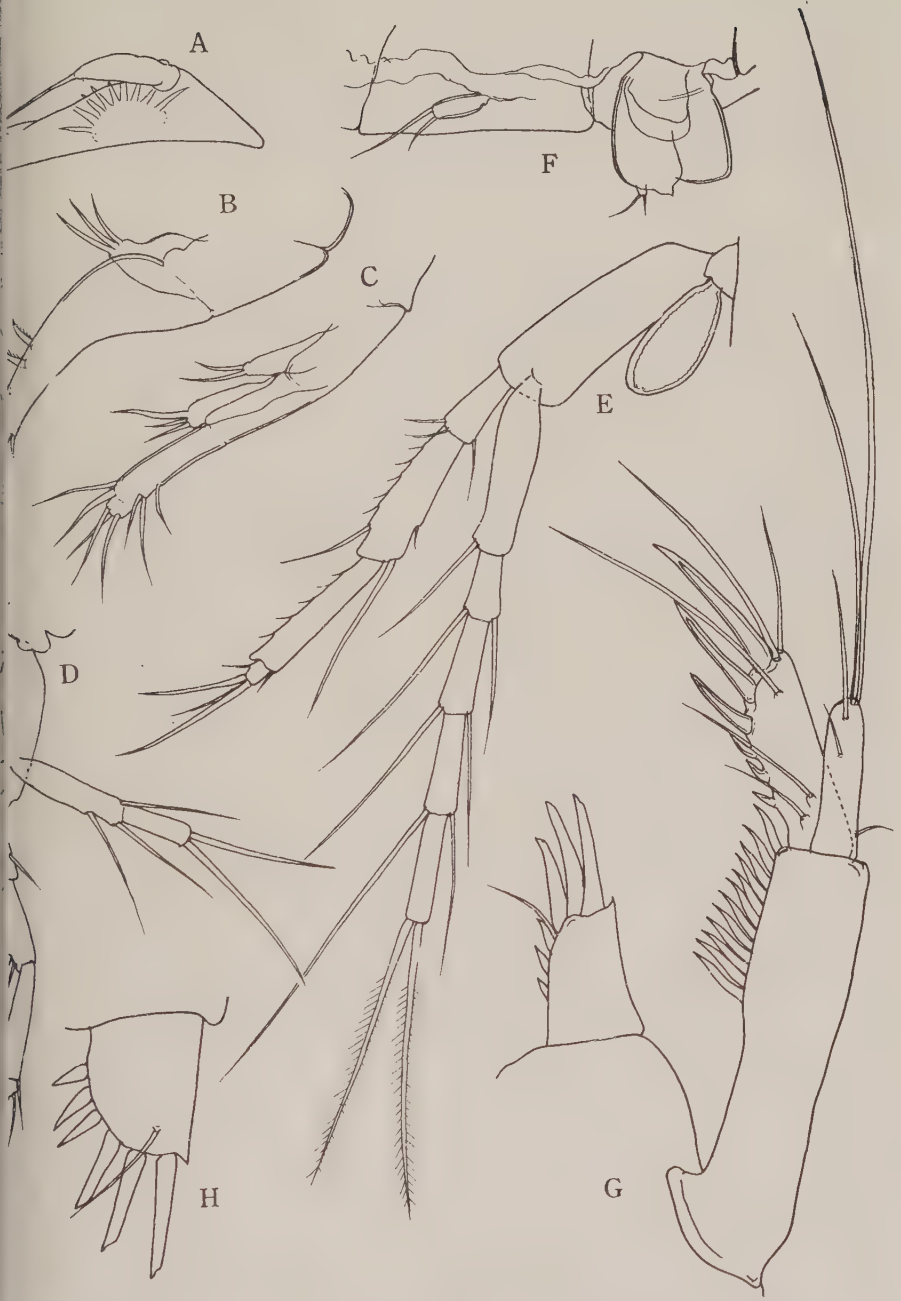


Fig. 1. *Allobathynella mirabilis* sp. nov., ♂, from Takéfu.

of pleopods present on the 1st abdominal somite; very small, uni-segmented
with 2 apical setae.

Each furcal lobe of telson shaped like a quadrant in dorsal aspect, outer ma
straight, inner margin rounded, armed with 6 spines, 3 large ones on the a
margin and 3 smaller ones on the inner margin; besides these, a single se
present on the dorsal surface near the distal margin. Uropods well-develo
basipodite, extending beyond the apical end of the telson, with a row of 12 sp
on the inner margin of the distal half; exopodite slender, nearly 1/3 of the le
of the basipodite, with 2 long apical setae, the longer one of which is near
times the length of the exopodite itself; endopodite longer and wider than
podite, somewhat widened distally, provided on the apical and inner mar
with 6 spines in two series, the one on the distal part consisting of 3 long
stout spines, which increase in length successively toward the longest apical



Allobathynella mirabilis sp. nov., ♂, from Takéfu. A, mandible. — B, maxillula. — C, . — D, left first pereiopod. — E, left fifth pereiopod. — F, eighth pereiopod and pleopod (right side). — G, telson and uropod. — H, telson, right lobe, dorsal view.

and the other proximal series consisting of 3 considerably shorter spines; bo these spines, there are 2 long setae present on the apex, and on the outer su 3 more setae, one long one near the apex and the other two near the base.

Locality. — A single male specimen was taken by Shun-Ichi Uéno in Oct 1956, in a well at the town of Takéfu, circa 30 km north of the city of Tsu Fukui Prefecture, on the coast of the Japan Sea. Female not yet known.

RÉSUMÉ

Nous présentons la deuxième espèce, *A. mirabilis* nov. sp., du genre *Allobathynella* Mo et Miura (1957). Elle diffère en quelques points d' *A. japonica* Morimoto et Miura, la espèce déjà connue de ce genre. Dans l'ensemble, elle ressemble plus aux espèces de *Bath* qu'à celles de *Parabathynella.* Elle a été trouvée dans un puits de Takéfu, ville située à envir kilomètres au nord de Tsuruga, sur le bord de la mer du Japon.

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ATION BETWEEN THE BREEDING AND MOULTING CYCLES IN CIRRIPEDES

BY

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INTRODUCTION

many Crustacea the male regularly copulates with a female just after she oulted. Examples may be cited from the majority of groups of Crustacea, ly from Branchiopoda, Copepoda, Mysidacea, Isopoda, Amphipoda, Macrura Brachyura. Before the sexual act the male often attends on or carries the le and may even assist her in freeing herself from the moult. The associa- of the males with the females before the latter moult is found not only in igher Crustacea, for example in portunids (Churchill, 1917-18), in some nura (Block, 1912; cf. Pike, 1947), in amphipods (Langenbeck, 1898; nes, 1903; Embody, 1911-12; Jackson, 1912; Clemens, 1950; Williamson, ; and Forsman, 1951, 1956), in isopods (Unwin, 1920; Sexton, 1924, 1928; uist, 1949; and Kjennerud, 1950) and Cumacea (Forsman, 1938; Fage,), but also in more primitive forms and in some Arachnida (see Childster,). Many of these have appendages for carrying and holding the female, for ple *Eubranchipus* (Pearse, 1912), *Artemia* (Williams, 1907), *Chirocephalus* d, 1850), harpacticoid copepods and the arachnid *Limulus* (Williams, 1907). also important for the male to recognize the female when she has moulted about to moult. In portunid crabs sex recognition is tactile (Childster, 1911) possibly also olfactory, as it is believed to be in *Pandalus* (Needler, 1931) n amphipods (Williamson, 1953). The soft female, when about to oviposit, rrespondingly passive and does not resist the male (Templeman, 1936; ens, 1950; Broekhuysen, 1955).

wever, there are many exceptions to this behaviour in Crustacea. In a number opical crabs a male copulates with a hard female, for example *Portunus* *icus, Uca pugilator* (cf. Broekhuysen, 1936), *Cyclograpsus punctatus* (Broek- n, 1941) and the oyster crab *Pinnotheres ostreum* (Christensen & McDer- 1958). Other examples include the freshwater crayfish (Andrews, 1904,), *Calocaris macandreae* (Carlisle, private communication), *Penaeus setiferus* kenroad, 1939) and the terrestrial Oniscidae (Schöbl, 1880); all except *eus* possess spermathecae or other means of storing spermatozoa.

e habit of consorting with an immature female has an obvious selective

advantage to the particular male as against other males. Moreover, the adva
of first finding a virgin female is especially important in species where a
copulation provides the sperms for several broods, as is quite common in
chyura. The essential feature which may have led to the development of
behaviour in the Crustacea is the fact that the female does not usually m
until immediately after a particular moult. In crabs this moult reveals the rou
and enlarged abdomen which becomes free to accommodate the 'egg sp
(Childster, 1911; Churchill, 1917-18; Broekhuysen, 1955). In Macrura s
setae for egg attachment are developed after this critical moult, a modific
referred to by Höglund (1943) as the 'breeding dress.' In Isopoda, Amph
and Cumacea, a marsupium to hold the brood is developed. Thus the mal
taking possession of an immature female, ensures that he is present to effect
lation after the moult. Moreover, in some isopods copulation can only take
during the moult. It must take place after the shedding of the abdominal exu
which uncovers the oviducal openings, but before the thoracic segments m
lest the oviduct become blocked by the enlarged oostegites (Unwin, 1920;
nerud, 1950). Copulation is similarly restricted in some mysids where the
are oviposited soon after moulting has occurred even in the absence of a
(Nair, 1939). In such forms males are attracted only by females which
moulted less than 12 hours previously. In animals where the female has s
brief period of effective fertility, the males must clearly be attracted t
consort with females at the appropriate time.

However, the advantage to the males of consorting with immature fe
could apply equally to many groups of animals which do not do so. Hence
is probably some further reason for this type of behaviour being comm
Crustacea. In species which have externally or loosely attached spermatop
copulation prior to moulting would result in their being lost. In the lo
Homarus americanus, Templeman (1936) found that the cast shell also incl
the annulus with the entire lining of the seminal receptacle, together wit
hard gelatinous mass and spermathophores which invariably plug the sem
receptacle. Had the ecdysis followed copulation, the female lobster would
lost the spermatophores. Many of the species of crabs which copulate in the
state have means of retaining sperms even for several moults (e.g. *Pinnothe*
However, others which copulate in the soft state also have means of st
sperms (e.g. *Cancer, Carcinus*).

Yonge (1937) suggested that the female lobster moults prior to copul
because the secretory activity involved in laying down new cuticle has been a
ted in Macrura to cement the eggs to the pleopods. Broekhuysen (1941) po
out that in Brachyura the eggs are attached by the perivitelline membrane o
egg itself, while Burkenroad (1947) considered that in *Palaemonetes* the i
fusion of adjacent egg membranes round the incubatory setae alone was res
sible for the attachment. However, neither of the latter authors have sugge
any convincing reason for oviposition following immediately on a moult.

here is yet another advantage in copulation following ecdysis, which is sim
to be associated with the habit almost universal in the Crustacea of th
ale carrying the brood externally. If copulation only takes place just after
oult, it ensures that the eggs are laid as early as possible during the intermoult
od. The chances of the brood being shed precociously are thereby minimized,
e the embryos have enough time to complete development, and hatch, before
end of the intermoult period of the parent. This argument only holds good,
ever, for those groups of Crustacea which continue to moult frequently after
urity. This may not be true in many species of Macrura and Brachyura which
ult only twice or thrice in a year, while the oxyrhynchan Brachyura, on reaching
erty, do not moult further (Carlisle, 1957). Penaeid prawns have no danger
osing the developing eggs with the moult, since the fertilized eggs are laid
ne sea; nevertheless, the habit is retained in some species. Burkenroad (1939)
orted that both in *Penaeus aztecus* and *P. brasiliensis* copulation followed
sis, but not in *P. setiferus*.

opulation and oviposition following ecdysis in the Crustacea may therefore
e several advantages. It is probably associated with the development of incu-
ory accessories. It reduces the risk both of losing stored spermatozoa and of
lding the brood prematurely with the cast skin. The soft condition acquired by
female will also render her a passive partner during copulation.

he intermoult period seems in some species of Crustacea to be extended for
ong as the young are attached (Hess, 1941) and the female then moults
n after the escape of the brood (Nouvel & Nouvel, 1935, 1937, 1939, 1940,
2; Höglund, 1943; Scudamore, 1948; Forsman, 1951, 1956; Sexton, 1924,
8; Unwin, 1920; Kjennerud, 1950). Scudamore (1948) explained the pro-
gation of the intermoult period in gravid crayfish in terms of inhibitory action
sinus glands caused by an impulse produced by the presence of eggs on the
opods, and succeeded in demonstrating that the egg-bearing female could be
le to feed actively and moult within a short time by removing the eggs artifi-
ly.

n a typical crustacean, therefore, the moulting cycle is closely interlocked with
breeding cycle so that copulation and oviposition occur just after the integu-
nt is renewed, and no further ecdysis takes places until the young have hatched
Cirripedes, since they do not carry the eggs in an externally visible manner,
e not until recently been investigated from this viewpoint. Crisp (1954),
vever, suggested that a moult might be expected to accompany copulation a
oes in other Crustacea. Barnes and Barnes (1956) suggested that it occurred
r fertilization. Recently Crisp and Patel (1958) demonstrated that usuall
ulation followed within a few days of moulting in operculate barnacles, and
in *Balanus balanoides* there was a definite period of anecdysis starting from
time that copulation occurred. Patel (1959) found that in the pedunculate
nacle *Lepas anatifera* L. the liberation of nauplii took place just before or
ultaneously with ecdysis and both copulation and oviposition immediately af-

terwards. The present paper extends these investigations to the following spe — *Balanus balanoides* (L.), *Balanus crenatus* Bruguière, *Balanus balanus* (*Balanus amphitrite* var. *denticulata* (Broch) and *Elminius modestus* Darwin.

SOURCE OF ANIMALS USED

For the experiments described below, unfertilized barnacles were require a condition fit to breed. Three species were obtained just prior to the comme ment of the normal breeding season. These were *B. balanoides* and *B. cren* conveniently obtained on living *Mytilus* shells from Bangor pier in October, from Port Penrhyn mussel beds in early January respectively. *B. balanus* dredged from Beaumaris Bay on *Modiolus* shells in January (Crisp, 1954). *minius modestus* breeds throughout the year, hence unfertilized individuals to be obtained by isolation and feeding in the laboratory as described in an ear paper (Patel and Crisp, 1960a). This species also was obtained on mussel sh from the piles of Bangor pier. *Balanus amphitrite* can occasionally self-ferti and was therefore suitable only for certain experiments. This species was obtai from Queen's Dock, Swansea.

INFLUENCE OF PHASE OF MOULTING CYCLE ON SUSCEPTIBILITY TO FERTILIZATION

Barnacles normally cross-fertilize if another individual is sufficiently close most operculate barnacles cross-fertilization is obligatory (Crisp, 1950, 1 1958), though in a few self-fertilization may occur (Crisp, 1954; Barnes Crisp, 1956; Barnes and Barnes, 1958). The former may be prevented f producing broods by keeping them isolated in dishes, as described previo (Patel and Crisp, 1960a). Mature unfertilized specimens which had been isolated and are referred to as 'experimental individuals' were then placed adja to freshly collected groups of specimens, called 'control groups,' which w mature and breeding normally. By this procedure the experimental individu could be given the opportunity to become fertilized at any time, and could s sequently be examined for the presence of egg masses in the mantle space. T control groups were also examined to ensure that animals with full vesicu seminales and recently fertilized specimens were present, in order to confi that some individuals present in the control groups could act as males. T experimental individuals were watched during their period of isolation for skins, and the moulting rhythm of each individual was thus established. T were then placed in contact with a control group for a standard length of t (1 to 3 days according to the species) at various phases of the normal moult cycle, and afterwards examined for the presence of fertilized eggs. From m such experiments it was possible to determine whether the phase of moulti had any influence on the capacity to become fertilized. All experiments we conducted at temperatures corresponding closely to those of the sea during t breeding season.

he results obtained are shown in Table I for three species. Both *B. balanoides* 3. *crenatus* had fairly long mean intermoult periods, hence the period allowed apse since the previous moult could be extended to over a week. On the hand, the short mean intermoult period of *Elminius* limited the period able for experimentation after moulting.

TABLE I

ntage of the experimental individuals fertilized at a given period after moulting when placed in contact with groups of breeding individuals

o. of days ter last moult	*Balanus balanoides* Inter-moult period (unfertilized) = 11-13 days at 10°-11°C. Contact period: 1 day (expt. I) 2-3 days (expt. II)		*Balanus crenatus* Inter-moult period (unfertilized) = 10-12 days at 8°-12°C. Contact period: 1-2 days		*Elminius modestus* Inter-moult period (unfertilized) = 6-7 days at 14°-16°C. Contact period: 1-2 days	
	No. of individuals tested	% fertilized	No. of individuals tested	% fertilized	No. of individuals tested	% fertilized
iment I						
1 day	38	15.8				
3 days	52	9.6				
6 days	107	18.0				
10 days	20	5.0				
iment II						
1 day	19	42.0	41	17.1	51	41.0
-3 days	13	31.0	35	28.5	15	53.0
-5 days	20	30.0	36	22.0		
-7 days	20	15.0	26	31.0		
-9 days	19	10.6	46	26.0	37	43.0
-11 days	13	0	88	11.4		
-14 days	39	5.1				

can be seen that some individuals at least of all three species were able to me fertilized at any period of the moulting cycle. In *Elminius* and *B. crenatus*, was no detectable influence whatever of the moulting phase on the frequency ccessful copulation. On the other hand, in *B. balanoides* there was in both riments a tendency for individuals which had moulted more than a week iously to copulate less readily than those which had recently moulted. This t was not due to any seasonal change which might have occurred, the period ertility being very short in this species (Crisp, 1960), since the individuals n at different phases in the moulting cycle were scattered over the whole od of breeding activity from early November to early December. There is, ever, another possible explanation of the difference shown by *B. balanoides*. a proportion of experimental animals could be kept for 10 to 15 days without lting; these were 'slow moulters.' We may therefore have selected individuals iologically different from, and perhaps less fertile than, the 'faster moulters.'

Such a correlation between moulting rate and fertility would not be surpri since normal individuals reach a peak of moulting activity just before the mencement of breeding (Crisp and Patel, 1958, 1960).

RELATION BETWEEN LIBERATION OF NAUPLII AND MOULTING CYCLE

The moulting cycle of a typical cirripede in relation to the breeding cyc diagrammatically illustrated in Fig. 1; x_1, x_2 ... x_6 represent consecutive mo O represents the moment of oviposition, which follows closely upon copula

FIG. 1

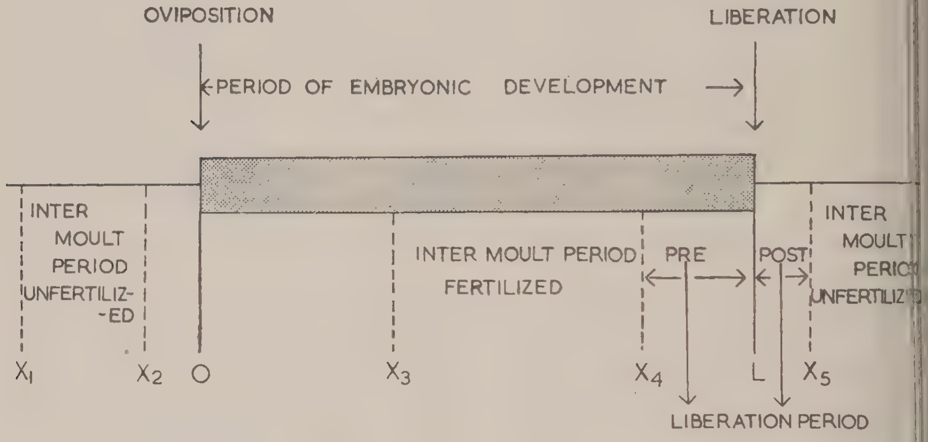

OVIPOSITION
LIBERATION
← PERIOD OF EMBRYONIC DEVELOPMENT →
INTER MOULT PERIOD UNFERTILIZ-ED
INTER MOULT PERIOD FERTILIZED
PRE
POST
INTER MOULT PERIO
UNFERTILIZ
X1
X2
O
X3
X4
L
X5
LIBERATION PERIOD

Fig. 1. Diagrammatic representation to illustrate the terms used to describe the possible relatio between the moulting and breeding cycles.

and L represents the liberation of fully developed nauplii. The interval, x and x_5 x_6, between consecutive moults in a mature barnacle carrying unfertil eggs in the ovary is the intermoult period for an unfertilized individual and be called intermoult period (unfertilized). The interval of time between con utive moults after oviposition but before liberation of nauplii, x_3 x_4, if s moults should occur, would be the intermoult period (fertilized). The period elapsed between liberation and the preceding moult x_4L will be called the liberation period of the moulting cycle. The interval of time between libera and the following moult Lx_5 will be called the post-liberation period of moulting cycle.

In order to relate the time of liberation to the sequence of moults, we obtai specimens from the shore during the breeding season and isolated them im diately by removing all except one from each mussel shell or other object which they were attached. At this stage it was not known whether they w carrying embryos or not. They were then kept in dishes and fed on *Arte* larvae at approximately natural temperature. In *B. crenatus* and *E. mode*

FIG. 2a E. modestus (FED)

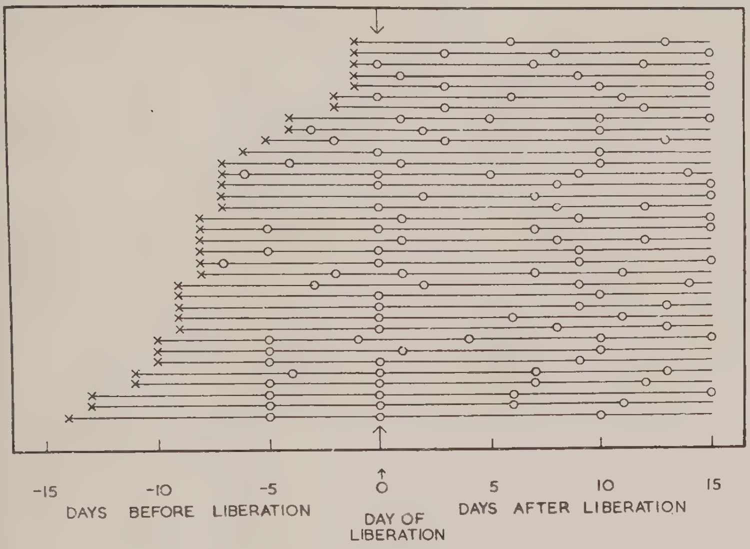
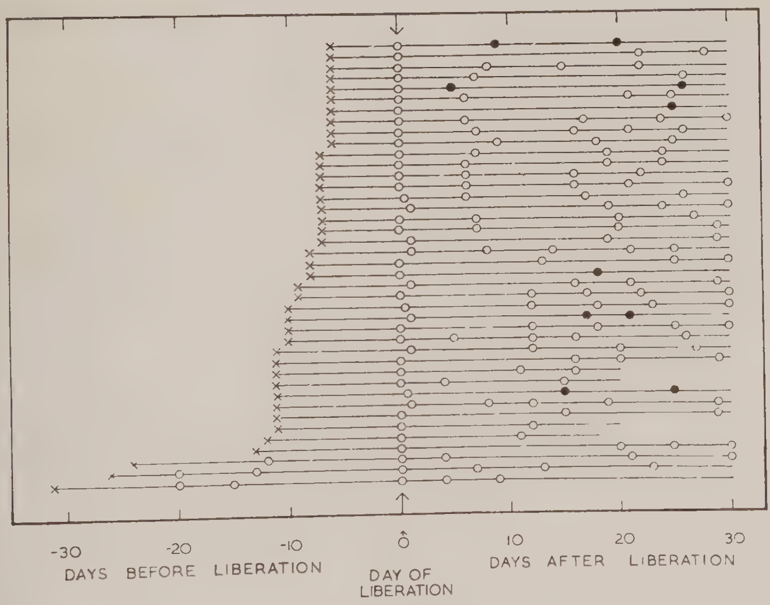


FIG. 2b B. amphitrite (FED)



2. Diagram showing how the history of each individual is represented. Each line represent period during which one individual was under observation. Each moult is recorded by an oper le. The time has been adjusted in such a way that all the individuals liberate at zero time *Elminius modestus*, (b) *Balanus amphitrite*. The solid circles indicate the moult of specimen which were found at the end of the experiment to be self-fertilized (see text).

similar experiments were also made on starved specimens. The dishes in w each specimen was kept were examined individually several times each day the presence of cast skins or clouds of liberated nauplii, the latter being to distinguish from the food organism *Artemia.* At the end of several we all the specimens or representative samples of them were examined to en that the majority of gravid individuals had liberated. We then knew from records of liberation which individual had been carrying embryos at the out and the exact period during which they were gravid. The total period dur which each gravid individual was carrying its eggs was divided by the num of moults given while in this condition; this gave the average intermoult pe (fertilized). The total period during which each individual was without br was similarly calculated and divided by the number of moults in the unfertili state to obtain the average intermoult period (unfertilized). In order to corre the results about the time of liberation it was found useful to record each in vidual history as a line on which each moult was recorded with the time s adjusted to zero at the day of liberation. This is illustrated for one experim on *Elminius modestus* and one on *B. amphitrite* in fig. 2.

In order to obtain the pre-liberation period (see above) the actual time betw liberation and the previous moult was recorded and averaged. Where no previ moult was observed because the liberation of nauplii occurred too soon after parent was isolated (e.g. nos. 1 to 8, and 11, etc. in fig. 2a), the observa was discarded for this purpose, since in these specimens there was no evid of an actual pre-liberation period. All the individuals which liberated were k until the moulting cycle was resumed in the unfertilized state, and the p liberation period similarly obtained. Thus we were able to compare the pre- post-liberation periods for all those in which moulting was observed, except those where both the cast skin and swarms of nauplii were found simultaneou in the dish. In these, of which there was a considerable number, we knew t the two processes took place within about 10 to 12 hours of each other (usua the overnight period when observations were not made), but we could not t whether moulting preceded or followed liberation. We can, however, put lim on the number of individuals which could have moulted within two days eit side of liberation. Table II gives the data for three species. It can be seen t the actual number of individuals in which moulting was observed during the t days prior to liberation was always much smaller than the number which w observed moulting during the same period after liberation. This suggests t in the majority of doubtful cases, where the two events were not separately served, moulting probably followed liberation. The very high proportion moults in which the two events occurred within about 12 hours of one anot is most significant, and clearly indicates that the moulting and hatching process interact in some way. Table III gives further details of the moulting of *Elmin* *modestus* in relation to its release of nauplii. Very few individuals moulted abo 24 hours before liberation, but during the period 12 to 24 hours after liberati

TABLE II

le showing the number of individuals moulting within two days before and after liberation

es	Condition of nutrition	% of the experimental individuals liberated during experimental period	No. of individuals kept 2 days either side of liberation	Number moulted within 2 days before	simultaneous	within 2 days after
renatus	Fed	89%	99	2	20	34
	Starved	25%	21	1	5	9
odestus	Fed	94%	123	10	67	36
	Starved	68%	13	0	3	7
mphitrite	Fed	100%	41	0	31	10
otal or pecies	Fed and starved	—	297	13	126	96

TABLE III

Details of moulting and liberation in Elminius modestus

he total number of individuals (fed and starved) which liberated was 189. these 8 were observed to moult within 24 hours before liberation and 39 after ration, while in 79 the two events could not be separated within 12 hours of b other. The following table gives the moulting rates about the moment of ration based on these observations. Values in brackets are calculated on certain assumptions (see text)

Time interval, tive to liberation	Number observed to moult	Moulting rates (% cast per day)
16 hours before	3	4.8%
3 hours before	5	at least 5.4% (30.0%)
ultaneous, two events not erved separately but urred within 12 hours of h other	79	
ours before to 3 hours after		— (40.0%)
hours before to 15 hours erwards (including ultaneous individuals)	92	39.5%
5 hours after	8	at least 8.4% (47.2%)
24 hours after	31	49.2%
al within 24 hours er side	126	33.3%

FIG. 3 a

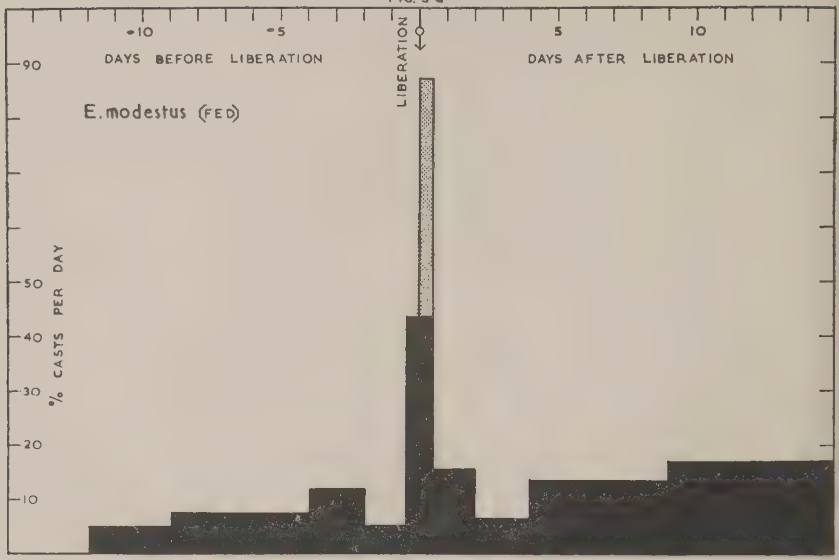


FIG. 3 b

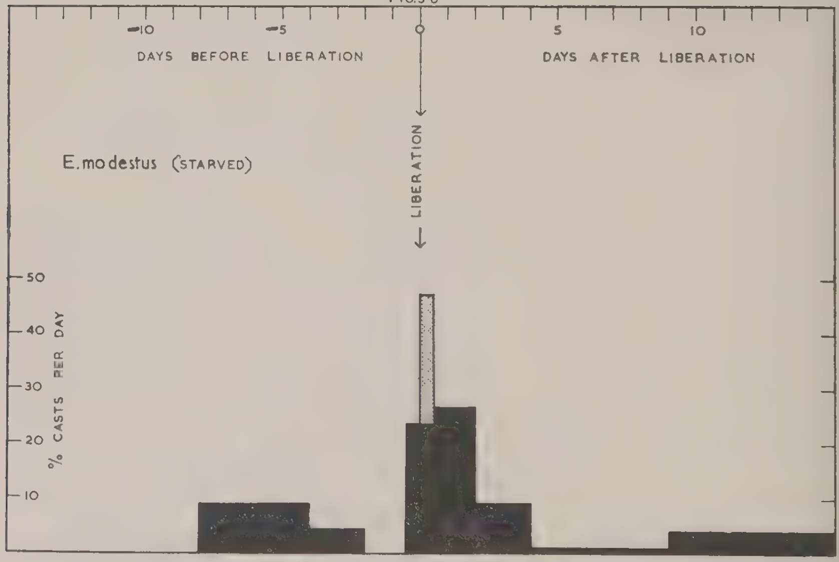


Fig. 3. Histogram showing the frequency of moults before and after the liberation of naup expressed as the percentage of barnacles casting per day. The full histogram is based on the assum tion that the moulting of individuals that liberated simultaneously is distributed equally before an after liberation. If these individuals are assumed to moult after liberation the histogram wou have the form of the stippled area. (a) *Elminius modestus* (fed); (b) *Elminius modestus* (starved (c) *Balanus crenatus* (fed); (d) *Balanus crenatus* (starved); (e) *Balanus amphitrite* (fed).

FIG. 3 C

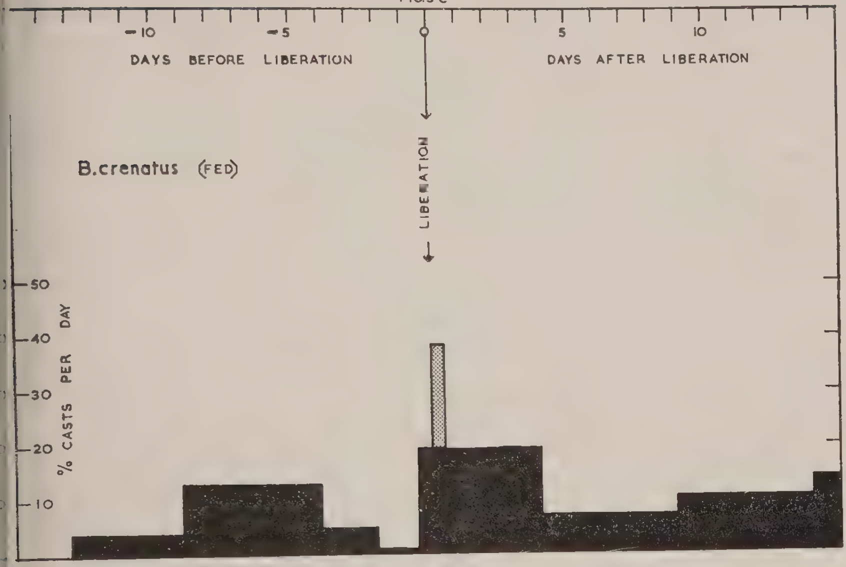
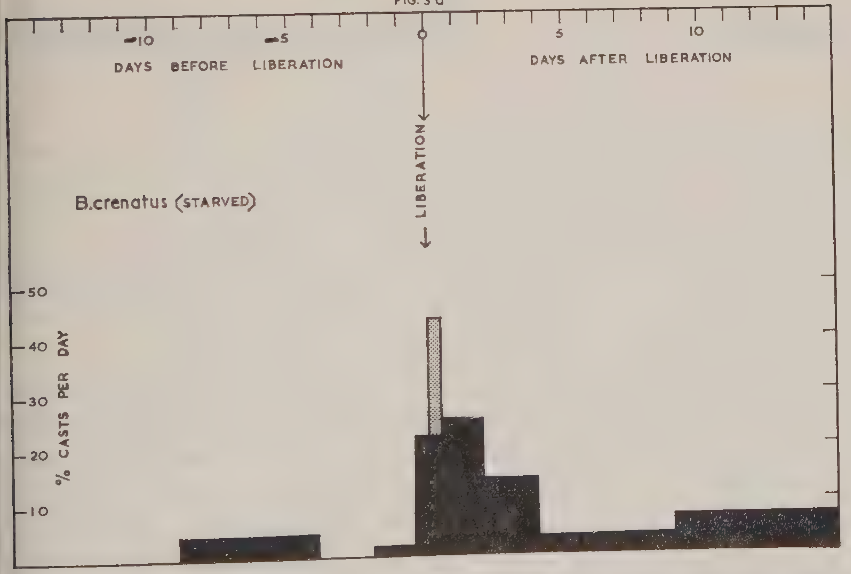


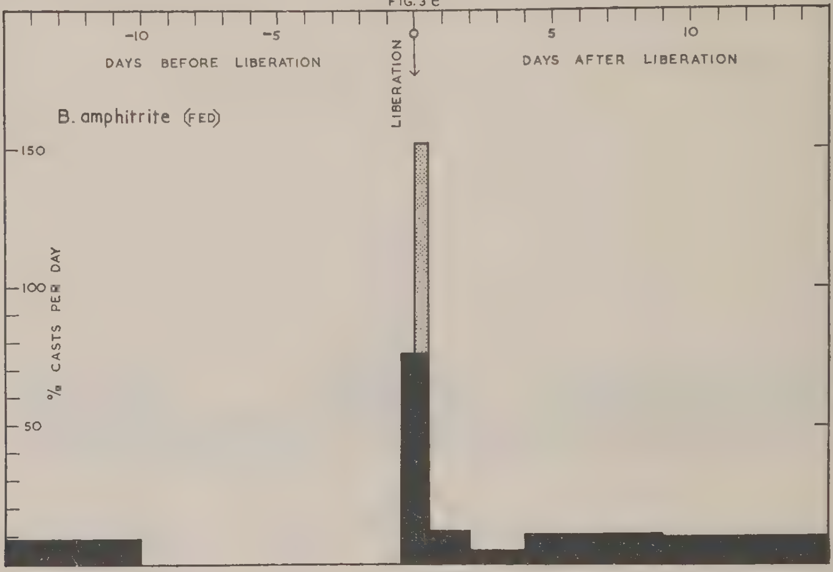
FIG. 3 d



moulting rate was very high. If we assume that the moulting rate of the ndividuals which were not observed to moult and liberate separately followed same pattern about the time of liberation as those which were observed, we insert hypothetical figures into column 3 of Table III. These figures are vn in brackets and indicate a rapid rise in moulting just before liberation, h was maintained up to at least 24 hours after liberation. Of all the individuals kept 66.7 per cent moulted within 24 hours from the time of liberat

Fig. 3, a, b, c, d and e shows by means of histograms the percentage per day per barnacle in relation to the time of liberation. For those individ

FIG. 3 e



which moulted and liberated apparently simultaneously we should obtain a p twice as high as that shown if we assume that the moults in fact succee liberation. However, whether we make this assumption or not, the relation the moults to the time of liberation is clearly not symmetrical especially in *crenatus* and *B. amphitrite,* a higher frequency of moults occurring in the per immediately following liberation, as already demonstrated numerically in Tal II and III. Observations, though on only a few specimens, indicated a sim behaviour in *B. balanus*.

In calculating the pre- and post-liberation periods (Table IV) we have assum that the 'simultaneous' observations were in fact examples of short post-liberat periods with an average length of 0.5 day, the maximum time interval betw our observations. None of our conclusions would, however, be seriously affect other than numerically, by making a different assumption.

The pre-liberation period is necessarily calculated from observations only up individuals observed to moult before liberation. Many individuals failed to mou for example in an experiment with 27 *Elminius modestus,* where the time oviposition of each individual was known, only 7 moulted before liberati though all moulted afterwards. The pre-liberation period obtained from th individuals observed to moult while carrying embryos may therefore be biass since it can include only a selection of the individuals used in the experime These individuals may have been more prone to moult than those which we t observed to moult prior to liberation, for the latter individuals, which we had exclude, could be regarded as having very long pre-liberation periods. Although mean pre-liberation period may be underestimated, it is nevertheless much ger than the post-liberation period and is sometimes of the same order as the rage intermoult period (fertilized) (Table IV).

Table IV shows also the values of the average intermoult periods obtained from tilized and unfertilized specimens. The former clearly moulted less frequently, ugh in all species except possibly in *B. amphitrite,* moulting took place in gravid cimens. *Balanus amphitrite* differed from others in self-fertilizing on occasions,

TABLE IV

*luence of nutrition on the average inter-moult period of fertilized and unfer-
ed specimens, with their pre- and post-liberation periods of moulting cycle*

cies	Range of temperature and season	Condition of nutrition	Average inter-moult period in days Unfertilized	Fertilized	Average pre-liberation period in days	Average post-liberation period in days
renatus	8°-14°C	Fed	8.4	14.6	6.2	2.8
	Jan.-April	Starved	13.2	23.5	5.7	2.0
odestus	14°-17°C	Fed	5.4	15.0	3.75	1.5
	June-August	Starved	15.2	16.0	5.30	1.8
mphitrite	17°-20°C May-July	Fed	9.6	16.2 (normally fertilized from field) 18.0 (self-fertilized after liberation)	14.0	0.6
alanus	9°-10°C Feb.-March	Starved	17.5	23.4	20.3	2.8

ce we could not be certain when it was carrying eggs except from the time iberation and the known rate of development of the embryos (Patel and p, 1960b). Figure 2b shows the behaviour of *B. amphitrite.* Moults of those viduals which were found at the end of the experiment to be self-fertilized r having been kept in isolation after liberating once, are shown by solid es. In this species we therefore obtained two figures for the intermoult od (fertilized), one based on normal individuals from the field and the r from self-fertilized specimens. No significant difference was observed een these two values.

EFFECT OF NUTRITION

e have shown previously (Crisp and Patel, 1958, 1960) that the moulting of barnacles when fed in the laboratory was significantly increased above that arved specimens.

A perusal of Table IV will show that in both *B. crenatus* and *E. modestus* t intermoult period (unfertilized and fertilized) of specimens fed on *Artemia* lar was usually considerably shorter than that of starved specimens. The same mig have been true of the pre-liberation period could this have been calculated witho being under-estimated, as explained above. However, the post-liberation peri was of about the same duration irrespective of conditions of nutrition, the mo usually occurring simultaneously with or very soon after the release of naup Liberation occurred more readily in specimens fed on *Artemia* larvae than in starv specimens, as can be seen by comparing the percentage that actually liberat throughout the whole period of the experiment (Table II).

CONCLUSIONS

The sequence of events common to many Crustacea may be summarised follows: (1) The male associates with an immature female, or one about to mou (2) Copulation follows soon after ecdysis. (3) The intermoult period of t ovigerous female may be extended beyond its normal term. (4) A moult ta place soon after the young are hatched.

The sessile habit makes it essential in regularly cross-fertilizing cirripedes the cypris larva to settle close to other individuals of the same species. In m species this is ensured by delaying settlement until the cyprid makes phys contact with an already settled individual (Knight-Jones and Stevenson, 19 Knight-Jones, 1953, 1955). Such behaviour corresponds in function with recognition of the female by the male and the carrying of the female until sh mature in non-sessile forms. However, in cirripedes there is no critical moult which a change in morphology or in the development of sexual structures sudde occurs; the sex organs develop slowly in relation to the moulting rhythm. Wher sexual maturity may take several weeks or months from the first appearance of nads, the moulting cycle is repeated at intervals of a few days (Crisp and Pa 1960). Since moulting is so frequent, it is not surprising that barnacles should capable of being fertilized at any stage in the moulting cycle. Our experiments three species showed that fertilization was not only possible but, with the single ception of *Balanus balanoides,* occurred with equal ease at any time in the cy

The intermoult period of ovigerous barnacles is generally longer than tha unfertilized animals, the increase being sometimes up to 50 per cent or ev more (Table IV). Moulting is infrequent during the 24 hours before the yo are liberated (figs. 3a-3c), hence the presence of egg masses in the mantle ca appears to delay ecdysis. The delayed moult, however, regularly accompanies follows the liberation of young, as in many other groups of Crustacea.

The Cirripedia do not carry eggs attached to the body, except for a very te porary connection between the egg sac membrane and the oviducal aperture the time of oviposition (Crisp, 1956), but freely in the mantle space. This sp usually appears large enough to accommodate more than one brood, but it scarc ver in fact does so. However, in species that breed continuously a further brood deposited soon after the previous one is liberated. Crisp and Davies (1955) gued that, since the ovary often appears ready to discharge a further batch of gs before the previous brood is hatched, some physiological mechanism must strain oviposition as long as there are egg masses present. Hence the hatching the brood not only removes the inhibition on breeding, but also, as we have early shown, is usually accompanied or closely followed by ecdysis. As a result, hen breeding is normally resumed and the barnacle is ready to be inseminated surrounding individuals acting as males, ecdysis has just taken place. A similar ain of events is found in the pedunculate *Lepas anatifera* (cf. Patel, 1959). It llows that the Cirripedia, while able to breed during any part of the moulting cle, probably do so most frequently just after the post-liberation ecdysis.

We have observed ecdysis of the thorax, prosoma, and appendages of many ecies successfully accomplished in the gravid state, though on some occasions has been accompanied by a loss of one or both egg masses. Moulting while bryos are present may therefore be disadvantageous. The danger is minimized extending the intermoult period while the egg masses are developing, and by laying oviposition until early in the next intermoult period. These mechanisms likely to be successful only if embryonic development can be completed ween two successive moults. In figure 4 the period of embryonic development plotted against the intermoult period for several species and at a number of nperatures. The line drawn at 45° through the axis represents equivalence ween the two periods. It can be seen that in these species, which all breed ntinuously during their appropriate season, the time required for embryonic velopment is of the same order of magnitude as the time elapsing between ults. Since the intermoult period has been averaged over a population con- ning individuals of all kinds, it will in ovigerous animals be longer than the ues shown by a factor of up to half.

Retention of embryos between moults is therefore possible in all the species wn and over the wide range of temperatures covered. A notable exception, vever, is *Balanus balanoides*, a species which breeds only once annually. In perate latitudes embryos of this species have a period of development of up 150 days (see Crisp, 1959), but a short moulting cycle of 10 to 15 days, ugh the first moult after oviposition is considerably delayed (Crisp and Patel, 0). It is possible that the period of development is abnormally prolonged in species, since Barnes and Barnes (1959) obtained much more rapid develop- nt of egg masses which were continuously aerated in vitro than was found viously by Crisp (1959), whose experiments were conducted under static con- ons and which agreed more closely with the rate of development in vivo.

he moulting rhythm and the rate of development are influenced similarly only by temperature but also by nutrition. Starvation has been known to lead gradual increase in the interval between moults, but does not seem to have h influence on the interval between liberation and the moult following. It therefore delays the time at which the moult takes place. Hatching of the developing embryos is also delayed in starved individuals, as was first noticed i *Balanus balanoides* (cf. Crisp, 1956) and this appears to be general to man species (see Table II, column 3). Possibly these two phenomena are connected if, for example, the secretion of the hatching substance which brings about th

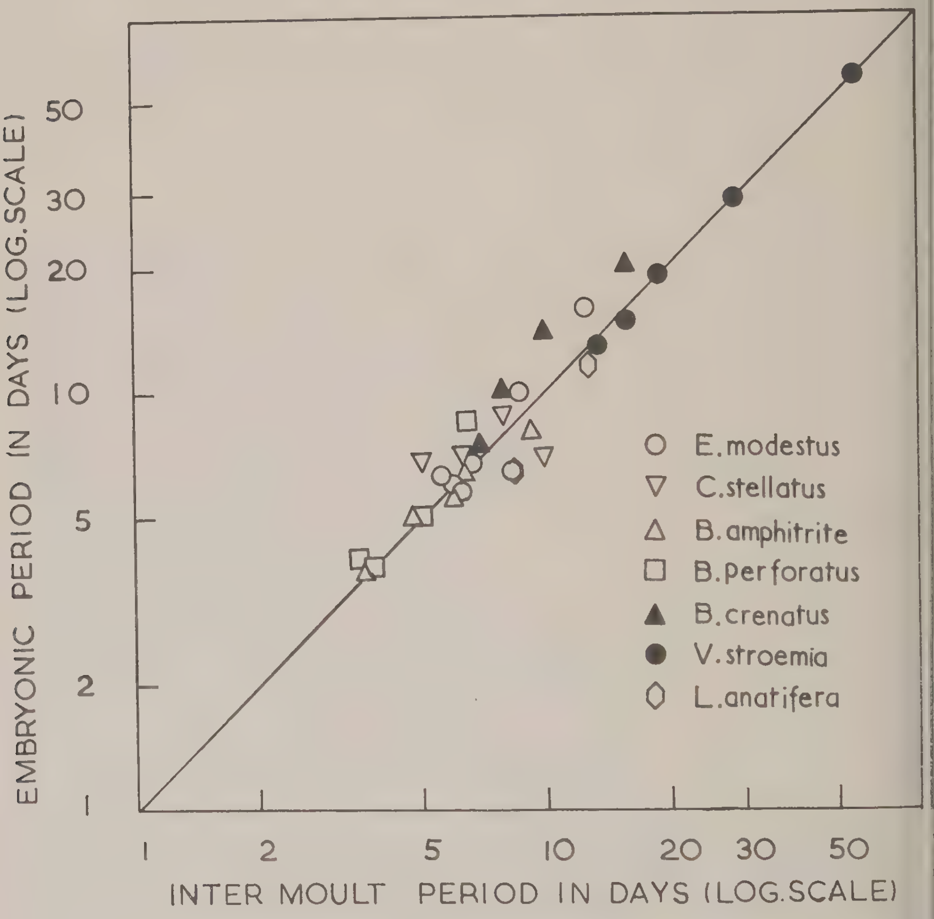


Fig. 4. Correlation between inter-moult period and period of embryonic development *in vitro* several species of barnacles. Several entries for one species refer to measurements at differ temperatures. Details of temperature dependence in rates of development and moulting are to found in Patel and Crisp, 1960a, and Patel and Crisp, 1960b, respectively.

liberation of nauplii were associated with the same changes that lead to t post-liberation ecdysis.

Over a wide range of conditions of temperature and nutrition therefore barnacle which has been fertilized just after a previous moult will normally ready to moult again by the time that the embryos are about to hatch, and t ycles of breeding and of moulting are thus enabled to keep in phase with each ther.

RÉSUMÉ

L'influence de la phase du cycle de mue sur la susceptibilité à la fécondation chez les cirripèdes a été examinée. Juste avant la saison de procréation, des spécimens adultes de *Balanus balanoides*, de *Balanus crenatus* et d'*Elminius modestus* ont été isolés pendant environ quinze jours et ensuite placés en contact avec des groupes d'individus en état de procréation pendant une période de 1 à 3 jours. Les spécimens ainsi isolés, chez qui la phase du rythme de mue était connue, ont eu l'occasion de se féconder. Chez *B. crenatus* et *E. modestus* il n'y avait aucune preuve que la phase du cycle de mue eût une influence décelable sur la fréquence de la copulation menée à terme. Chez *B. balanoides*, par contre, il y avait tendance pour les individus qui avaient mué plus d'une semaine auparavant de copuler moins volontiers que ceux qui avaient récemment mué.

Dans toutes les espèces, excepté peut-être *B. amphitrite*, qui à l'occasion s'est fécondée elle-même, une mue apparaissait quelquefois pendant qu'elles étaient porteuses d'embryons. Néanmoins, la période entre les mues chez les cirripèdes gravides était dans toutes les espèces beaucoup plus étendue que chez des spécimens non porteurs d'embryons.

Une dépouille apparaissait soit en même temps que la libération de nauplii, soit peu après Seule une petite proportion des *E. modestus* et une proportion plus faible encore des *B. crenatus* ont mué pendant les 24 à 48 heures avant la libération. Le taux de mue était, cependant, très élevé au cours de la libération et deux jours après. Généralement la période entre la mue précédente et la libération était plus significative que la période entre la libération et la mue suivante.

La période moyenne entre les mues chez les spécimens fécondés et non fécondés était largement augmentée si les parents n'étaient pas nourris. La période prélibératoire des spécimens à jeun était augmentée, mais non la période postlibératoire du cycle de mue. Que les adultes aient été nourris ou non, en général une mue suivait de près la libération.

Chez les cirripèdes qui procréent sans interruption, mais non chez *Balanus balanoides*, la période moyenne entre les mues est approximativement égale au temps de développement des embryons dans une large variété de conditions de température et de nutrition. Pourvu que le ponte apparaisse peu après une mue, ces embryons peuvent alors normalement éclore au moment de la mue suivante ou avant.

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THE CLADOCERA OF THE SWAMPS OF UGANDA

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The report which follows is concerned with collections which the author ma in Uganda between September 1956 and June 1957 while he was holding Goldsmiths' Company Scholarship at Makerere College. He worked with t Nuffield Swamp Research Team who are investigating the ecology of swam and the physiology of swamp animals. Cladocera are fairly common in the swam and this short investigation showed some features of their biology.

Swamps form three per cent of the land surface of Uganda and papyrus (*perus papyrus* L.) is the dominant plant. Papyrus occurs at the edge of lak forming 'lake swamps', and in river valleys, forming 'valley swamps', where flat valley basins become choked with the upright stems and entangled rhizo of the papyrus. Though the water in them appears to be almost stagnant, volume of water passing through them may be high and, after heavy rain, flow of water may be rapid. Six different habitats were associated with papyrus swamps and they are described below and shown in fig. 1.

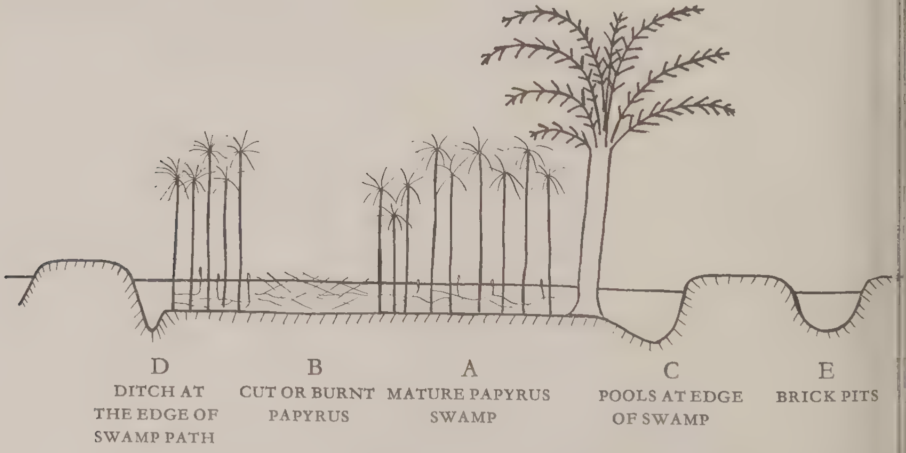
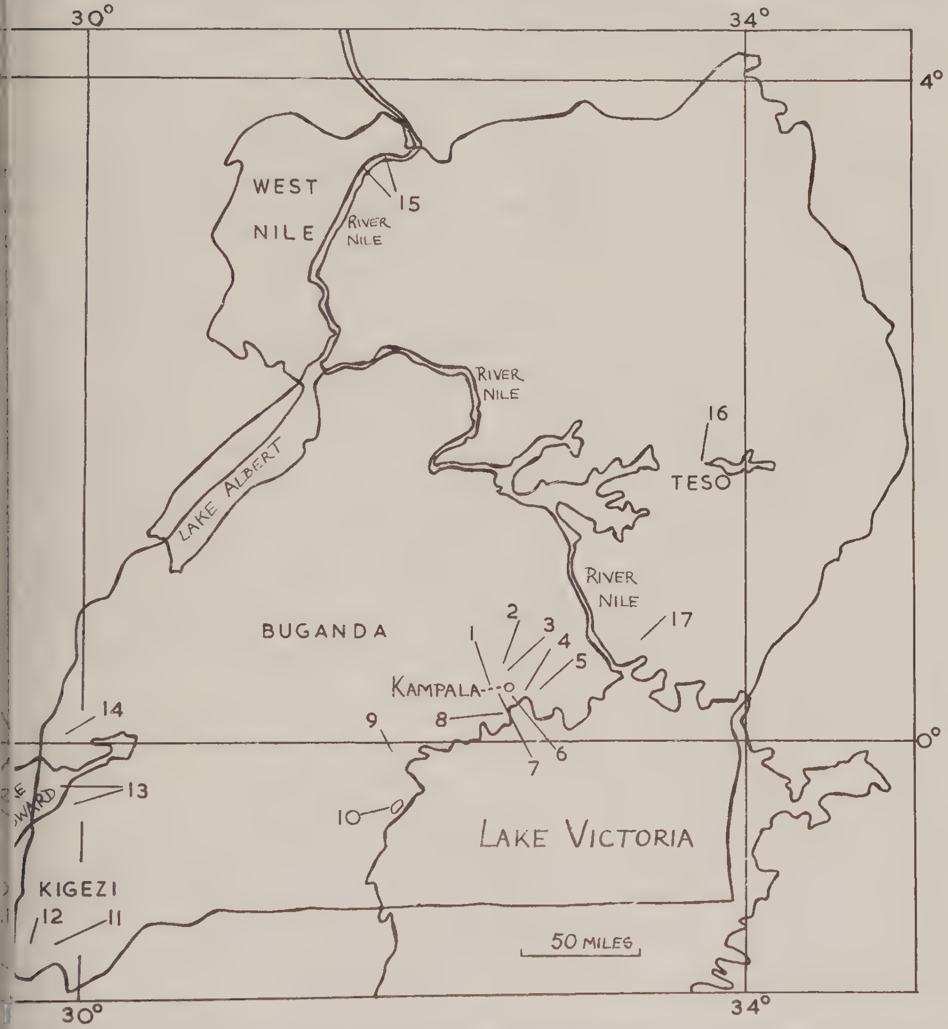


Fig. 1. Classification of the habitats of Uganda papyrus swamp Cladocera.

To find which species are characteristic of swamp conditions, collections w made over a wide area of Uganda. The places visited are shown on the m (fig. 2); they included Kigezi, the region in South-West Uganda where t altitude is about 7,000 ft and at night the temperature is much lower than rest of the country. The species found during this survey are shown in tables and III. Study of the literature has shown that most of these species are charac- istic of tropical swamps in other parts of the world.

Two swamps near Kampala were visited about twice in each month to give


30°
34°
4°
0°
WEST NILE
RIVER NILE
15
RIVER NILE
16
TESO
LAKE ALBERT
RIVER NILE
17
BUGANDA
1
2
3
4
5
KAMPALA
8
9
6
7
14
13
EDWARD
10
LAKE VICTORIA
KIGEZI
12
11
50 MILES
30°
34°

2. Map of Uganda showing places where collections were made. (Crown Copyright. Reproduced by permission of the Controller of H.M.S.O.).

ormation about distribution within a particular swamp and also about seasonal iation. But the seasonal variation in 1957 may have been unusual because the period characteristic of February and March did not commence until March extended into April and May. The habitats which were studied in detail are cribed in table I. A few isolated measurements of oxygen concentration, ob- ed by a modified Winkler method (Beadle, 1958) are quoted; but they need replication which was not possible in the short time available for the survey. T report is presented under the species rather than under accounts of the habita

I am greatly indebted to Professor L. C. Beadle of Makerere College a Dr. J. P. Harding of the British Museum (Natural History) for much advi and assistance, and also to the Worshipful Company of Goldsmiths whose gra enabled me to carry out this survey.

METHODS

Collecting was made difficult by the amount of plant debris in the swam water. A white dish dipped into the water often gave more satisfactory coll tions than a net. Most of the collections were made with a bucket (volume abo 8 litres) and the bucketful of water was passed through a stack of three sie of 10, 50 and 80 meshes to the inch. The larger sieve removed much of t plant debris and the two finer sieves held the Cladocera. Four bucketfuls we used in a standard collection and the sieves were washed out in a standard mann to give a very rough indication of changes in abundance of the Cladocera. bottle apparatus (volume 1 litre) arranged so that it could be opened and fill at a particular place and depth was most useful and it showed the importan of microhabitats in the ecology of Cladocera.

Collections were observed alive in the field with a lens and those that w worth keeping were preserved in formalin in the field, sometimes after n cotization with urethane. Living and preserved material was examined in zoology laboratory of Makerere College. Polyvinyl lactophenol was used as mountant for permanent preparations with either lignin pink or chlorazol bl for a stain.

CLASSIFICATION OF HABITATS

Type 1. Papyrus swamp.

1. A. Mature papyrus swamp. The stems are 12-14 feet high. Sub-dominant plants, mai *Dryopteris* sp., occur and the light intensity at water level is very low. The depth of water varies from swamp to swamp and with the amount of rainfall. In most swamps i rarely less than 3″ or more than 24″, though any one swamp may reach these limits du the year. Collecting in this habitat was an energetic and unrewarding business as few Clado were found.

1. B. Cut or burnt papyrus swamp. The papyrus stems are used for thatching and someti areas of up to 1,000 ft square are cut. The papyrus heads are left to decay and the amo of decaying material in the water is very high. In dry weather the papyrus is inflamm and it is sometimes set on fire. The great difference between this type of habitat and mature swamp is the amount of light that reaches the water.

   The papyrus grows rapidly and was 10 ft high in less than nine months after it had b cut, so conditions soon revert to those of type A.

1. C. Pools at the edge of the swamp. Most swamps have pools at the edge in which the wa is almost stagnant. They are frequently shaded by the phoenix palms which grow by th Cladocera were often very abundant in them.

1. D. Ditches at the side of swamp paths. Most of the swamps are intersected by paths wh are raised rather above the level of the swamp and a ditch forms at the side. Cladocera w

fairly common in this habitat and collections were often made here rather than elsewhere in the swamp because it was accessible.

E. Brick pits. The silt at the swamp edge is useful for building and there are often pits by the edge of the swamp where building material has been removed. The pits are about 2 to 6 feet deep and they fill with water.

F. Open water. In the broad river valleys, like that of the Nile, there may be a wide expanse of open water between the fringe of papyrus at the edges. The water is usually slow moving and conditions in the open water are more like those of a lake than a swamp.

e 2. Grass swamps, with *Miscanthidium violaceum* the dominant plant.

e 3. Artificial fish ponds.

e 4. Natural lakes, including the very large lakes like the Victoria Nyanza and Lake Edward, and the smaller crater lakes.

TABLE I

Habitats studied in detail

me and symbol	*Description*	*Oxygen concentration mgms/litre*
Portal Road at le 7. FPR 1	Ditch at the edge of a road across the swamp Type 1D-1A	10 a.m., May 13 0.1
Portal Road at le 7. FPR 111	Region of swamp cut during November Type 1B-1A	10 a.m., May 13 0.4
sa swamp kasa V	Sunlit pool at edge of the swamp. About 30′ × 20′ and 3-4 ft deep. Contained many green Protozoa Type 1C	3 p.m., May 9 3.0
sa swamp kasa VI	Heavily shaded pool almost touching Bukasa V. Type 1C	3 p.m., May 9 0.4
sa swamp kasa VII	Very small pool near Bukasa V Type 1E	3 p.m., May 9 1.0
sa swamp kasa XII	Ditch at the edge of the swamp. Type 1D	3 p.m., May 9 0.7

TABLE II

Distribution of common swamp Cladocera in Uganda

Place and Altitude (in feet)	Reference on Map	Total number of collections	Dates	Types of habitat	Pseudosida bidentata	Simocephalus exspinosus	Ceriodaphnia cornuta	Moinodaphnia macleayi	Ilyocryptus spinifer	Macrothrix triserialis	Macrothrix goeldii
Papyrus Swamps:											
Mile 7, Fort Portal Road 4,000 ft	1	50+	Oct.-May	ABD	+	+	+	+	+	+	—
Bukasa 4,000 ft	5	50+	Oct.-May	ABCD	+	+	+	+	+	+	—
Luzira 4,000 ft	4	2	Jan.	D	+	—	+	+	—	—	—
Namulonge 4,000 ft	2	2	June	A	—	—	—	—	+	—	—
Mile 7, Masaka Road 4,000 ft	7	1	Nov.	A	—	—	—	+	—	—	—
Katonga river, Masaka Rd 4,000 ft	9	5	Feb.	AD	—	—	+	+	—	—	—
Lake Bunyoni outlet 7,000 ft	11	5	Dec.	AD	—	+	—	—	+	—	—
Swamp by Lake Mutanda 7,000 ft	12	2	Dec.	D	—	+	—	—	—	—	—
River Nile at Dufile and Laropi 2,000 ft	15	8	April	AF	+	—	+	+	+	+	—
Lake Salisbury outlet, Teso 3,000 ft	16	4	Feb.	AF	+	—	—	—	+	+	+
Lake Nabugabo 4,000 ft	10	2	Feb.	AF	—	—	—	—	—	—	+
Brick Pits:											
Bukasa 4,000 ft	5	25	Oct.-May	E	+	+	+	+	+	—	+
Kaazi 4,000 ft	6	2	Sept.-Dec.	E	—	—	+	+	—	—	—
Bugerere Road 4,000 ft	3	3	Oct.-Nov.	E	—	+	+	+	—	—	—
Lakes and Fish Ponds, open Water:											
Lake Bunyoni and Fish Ponds	11	6	Dec.	3,4	—	+	+	—	—	—	—
Lake Mutanda	12	1	Dec.	4	—	—	—	—	—	—	—
Kikorongo Crater Lake	14	1	Dec.	4	—	—	—	—	—	—	—
Lake Edward and Crater Lakes	13	3	Sept.	4	—	—	—	—	—	—	—
Busoga College Pond	17	1	Feb.	4	—	—	—	—	—	—	—
Lake Victoria	—	3	Sept.-Dec.	3	—	—	—	—	—	—	—
Kajansi Fish Farm	8	3	March	3	—	—	—	—	—	—	—

TABLE III

Other Cladocera recorded in Uganda

pecies	*Notes*	*Place on map*
hanosoma sp.	Common in plankton in Lake Edward. Also in plankton from the Nile at Dufile.	13 15
opsis ciculata	Found in swamps on the River Katonga, River Nile at Dufile and Laropi, and in the outlet from Lake Salisbury.	9 15 16
nia longispina	Lake Mutanda and fish ponds in Kigezi.	11, 12
cephalus vetulus	A few specimens were found in the swamp at the edge of Lake Bunyoni, by its outlet.	11
cephalus rulatus	At least 10 specimens found in small pools between the tussocks of *Loudetia* in the seasonal grass swamp at Mile 7 on the Masaka to Bukakata road.	10
oleberis	Occasional in pools by swamps at Bukasa.	1
obably *S. kingi*	Once, after rain, in the swamp at Fort Portal Road.	5
a sp.	Common in fish ponds in Buganda and Kigezi and in crater lakes near Lake Edward.	8 13 14
a longirostris	A typical swamp species. Common in the Fort Portal Road and Bukasa swamps, and also in Teso, but not found elsewhere in Uganda.	1 5 16
rella uicaudis	Occasional. Never very common. Found at Bukasa, in a pool, in Teso, and in a weed-filled backwater of the Nile among Nile Cabbage.	5 15 16
gia sp.	Busoga College Pond (one specimen) and the River Nile at Dufile (two specimens).	15 17
a sp.	Specimens of this genus were present in many collections. The species *A. affinis* and *A. monacantha* were identified.	
evedia serrata	Common in the swamp at Bukasa. They were reddish in colour and may contain haemoglobin.	5
oxus hastatus	Present in the ditch at the edge of the swamp at Bukasa.	5
oxus striatus	Present in the ditch at the edge of the swamp at Bukasa.	5
oxus chappuisi	Present at the same place as the above.	5
orus eurynotus	Common in pools near swamps, in Buganda. Also found in Teso.	1 5 16

NOTES ON THE INDIVIDUAL SPECIES

Pseudosida bidentata Herrick, 1884

Identification. The synonymy of *P. bidentata* and *P. szalayi* will discussed in a separate paper (I. F. Thomas, Review of the genera *Pseudos* Herrick, 1884 and *Latonopsis* Sars, 1888. Crustaceana, in press).

Distribution and ecology. In the pools Bukasa V and Bukasa V *P. bidentata* was always present. It was very abundant between November a January and again in April and May, but it was much less frequent in Febru and March. In the heavily shaded pool, Bukasa VII, it occurred on some occasio but not on others.

Numbers in samples of 1 litre, taken at Bukasa V on 9 May were:

Bottle opened 5 cms below surface: 19, 21, 110, 10.
Bottle opened 20 cms below surface: 20, 20, 31.
Bottle opened 40 cms below surface: 3.

These figures agree well with estimates of 30 and 90 per litre when f bucketfuls of water were used to collect a sample.

P. bidentata was much less common in the swamps than in pools by the swam At FPR 1 it was present in only 1 out of 14 collections made between mid-Nov ber and mid-May, and its occurrence, on 10th December, followed two days heavy rain when the level of water in the swamp rose 8 inches. At FPR in the region where the papyrus had been cut, it was present in 4 out o collections. It was never abundant there and its occurrence was sporadic.

P. bidentata was not found in the high altitude swamps in Kigezi, but it common in the rest of Uganda. It occurred among the papyrus at the edge the River Nile near the Sudan border, but was not present in the plank from the open water of the Nile at the same place nor among the floating pla of Nile Cabbage (*Pistia stratiodes*).

Ephippia were recorded on only one occasion; males were not found. None the specimens found were pigmented.

Distribution outside Uganda. *P. bidentata* and *P. szalayi* (wh I consider is synonymous) have been recorded frequently from many parts the tropics or near-tropics. For example, Stingelin (1904) records *P. szalayi* f Sumatra in sunny pools and pools rich in algae, and swamps; Daday (19 records *P. szalayi* from swamps around Lake Nyasa; Ruhe (1914) records *bidentata* from Cape Province in South Africa and Birge (1910) has records the same species from weed filled pools in the Southern United States of Ameri

Conclusion. The characteristic habitat of *P. bidentata* is probably sta nant pools from which it may be carried into the swamps during flooding may remain and reproduce there but it probably cannot tolerate mature swa conditions. It appears to be more characteristic of sunlit areas than ones wh there is little light, perhaps because unicellular green algae are more abund there. But its food has not been investigated, nor have its oxygen requiremen

Simocephalus exspinosus (Koch, 1841)

dentification. There was no difficulty in identifying this species, ich Harding (1957) considers synonymous with *S. australiensis* Sars, 1888. e comb on the claw was distinct. The carapace was marked with long parallel es.

istribution and ecology. Though it was found in most parts of anda, its distribution in a particular region was local. It was present in a ditch the side of the swamp at Bukasa XII, but absent from a region fifty yards ay where the papyrus had just been cut. It was very abundant among the aying papyrus heads in a region which had been cut two months previously, Fort Portal Road. It was absent from a heavily shaded pool at Bukasa VI, present in a heavily shaded ditch at Fort Portal Road swamp.

imocephalus exspinosus lives among aquatic plants, to which it attaches itself, it moves from plant to plant in short hops. It sinks to the bottom rapidly ess it is carrying out rapid swimming movements. I came to associate it with ions where there was a large amount of decaying plant material, but where gen concentrations were probably not low because the places were shallow sunlit. Specimens from Bukasa XII were pigmented and probably contained moglobin.

his species was common at Bukasa V in January and February but was absent March, April and May.

istribution outside Uganda. *S. exspinosus* is cosmopolitan. Its irrence in the high altitude region of Kigezi is consistent with it not being fined to tropical conditions.

Ceriodaphnia cornuta Sars, 1885

riodaphnia cornuta Sars, 1885: 26, pl. 5 figs. 1-3; Rzoska, 1956: 505, fig. 1; Harding, 1957 fig. 5.

riodaphnia rigaudi Richard, 1894: 239; Delachaux, 1917: 81, fig. 3; Jenkin, 1934: 144, 3-6.

dentification. There was no cephalic horn in any of my specimens. antennules are not quite as long as the rostrum; the lateral seta on the nnule is slightly nearer the distal end than the middle (exactly as figured Harding, 1957). There are five or six anal spines. The head is more depressed in those figured in Rzoska (1956). The shell markings are indistinct.

nkin (1934) refers to the hairiness of the carapace, which is shown in Daday's wings (Daday, 1910: pl. 8 figs. 9 and 10) and is also illustrated by Delachaux 17: 82, fig. 3). Many of my specimens had vorticellids attached to the head carapace, and the hairs figured might well be the stalks of vorticellids.

his species was common in swamps and fish ponds. It was absent from Bukasa the Fort Portal Road swamp in March, but was recorded again at Bukasa r an absence of eight weeks. Ephippia were found in two different habitats when the population density in that place became very high. The numbers at an one place seemed to show marked fluctuations. Males were not recorded. In on place [FPR 1(d)] where it was usually not present, it occurred after floodin in the swamp. It was not recorded in Teso.

Moinodaphnia macleayi (King, 1853)

Identification. There was no difficulty in identifying this species.

Distribution. Very common near Kampala where it was a characte istic member of the fauna of the swamps and swamp pools, but it was not re corded in Kigezi or in Eastern Uganda. It was common in the swamp at Bukas and occurred in six out of seven brick pits near the swamp. It was the onl Cladoceran recorded from the Masaka Road swamp.

Seasonal variation. It was present throughout the period between Novembe and May at Bukasa V, but was absent in January and February at Bukasa VII and FPR 1. The marked seasonal change in abundance at FPR 1 is shown i table IV.

TABLE IV

Abundance of Moinodaphnia *and depth of water in the swamp at Fort Portal Road, Mile 7*

Date	*Depth of water cms*	*Estimate of abundance of Moinodaphnia*	*Proportion with ephippia*	*% with ephippia*
19 Nov.	40	Very abundant	31 in 476	6.5
21 Nov.	40	Very abundant	23 in 134	17.0
26 Nov.	45	Very abundant	5 in 301	1.7
3 Dec.	44	Abundant	0 in 51	0
10 Dec.	67	Abundant	0 in 142	0
16 Dec.	41	Abundant	0 in 126	0
22 Jan.	25	Absent	—	—
28 Jan.	31	Absent	—	—
4 Feb.	45	Absent	—	—
15 Feb.	38	Rare	0 in 4	—
11 March	52	Common	—	—
25 March	75	Common	—	—
1 April	48	Abundant	—	—
9 April	48	Abundant	—	—
6 May	54	Very abundant	—	—
13 May	62	Abundant	2 in 414	0.5
27 May	62	Abundant	Present	?

These observations show that ephippia were produced just before the dry seaso of January and February. Though males were looked for at the time of productio of ephippia, they were not found. (They are known, but appear to be uncommon they are described in Brehm, 1953).

bservations with the bottle apparatus are recorded in table V.

TABLE V

nbers of Moinodaphnia *caught in a 1 litre bottle opened at the depth stated*

Fort Portal Road swamp on 13th May:

	Sample A	*D*	*E*	*H*	*I*
th 2 cms:	20	16	176	69	87
	Sample B	*C*	*F*	*G*	*J*
th 20 cms:	5	1	5	30	5

ukasa V on 9th May:

	Sample A	*D*	*E*	*H*
h 5 cms:	2	5	92	28
	Sample B	*C*	*F*	*G*
h 20 cms:	1	2	5	4

se observations showed that *Moinodaphnia macleayi* usually lives very near e surface. They explained the fact that Mr. L. K. H. Goma, who was working wamp mosquitoes and collected with a dish, frequently caught more *Moino- nia* than my collections with a bucket suggested were present. In aquaria s in the laboratory they could be seen swimming near the surface. It is rising that Sars (1901), who raised the species from dried mud from Brazil, rds them as being at the bottom of his aquaria.

istribution outside Uganda. *Moinodaphnia macleayi* is pan- cal in distribution and is often recorded from swamp habitats.

onclusion. *Moinodaphnia macleayi* may evade conditions of low oxygen entrations by living just below the surface of the water. It would be inter- g to know if, like *Moina,* it is characteristic of areas which tend to dry up.

Ilyocryptus spinifer Herrick, 1882

lentification. The specimens show the armature of the post-abdomen ly as figured in Harding (1957, fig. 10), the long swimming setae on the nae, and the girdle of spines round the middle of each of the segments e branches of the antennae, and so clearly belong to *I. spinifer* Herrick, . The girdle of spines was not present in the Kigezi specimens but the features were. They were colourless or very pale yellow. Only those from mp near Lake Nabugabo (collection 253) were pigmented and were pink, hese were also *I. spinifer.*

istribution and ecology. This species was found in all parts of da, including Kigezi. It was usually uncommon, only two or three specimens found in each place, but it was very abundant in the sunlit pool Bukasa V, e as many as 40 per litre were collected. It was usually found among debris but, unlike *I. sordidus* which crawls rather than swims, these specimens sw freely. Ephippia were recorded at Bukasa V on 15th March, but males were seen.

This species survived longer than any other Cladoceran in experiments closed bottles in which the oxygen concentration was falling. Its distribut and the unexpected absence of pigment suggest that investigation of its physiol would be revealing.

I. spinifer is recorded throughout the tropics, sometimes under the synony *I. longiremis* Sars, 1888 or *I. halyi* Brady, 1886. Sars (1901) recorded tha *longiremis* swims and he also noted the pale yellow colour. He figured ephipp

Macrothrix triserialis Brady, 1886

Macrothrix triserialis Brady, 1886: 295, pl. 37 figs. 16-20; Harding, 1955: 338, figs. 34-36.
Macrothrix triserialis Brady var. *chevreuxi* Richard, Stingelin, 1914: 615, figs. 18,19.
Macrothrix chevreuxi Guerne & Richard, 1892: 530, figs. 3-6; Jenkin, 1934: 281, fig. Gauthier, 1951: 64, pl. 15.

Identification. The genus *Macrothrix* is easily recognised but m than forty species have been described from various parts of the world determination of species is much more difficult. But the two species *M. triser* and *M. goeldii* are easily distinguished.

I follow Harding (1955) in considering *M. triserialis* Brady synonymous *M. chevreuxi* Guerne & Richard. My specimens show the following charact The lines on the carapace are almost parallel; they curve backwards in the mi and anastomose very infrequently. The ventral margin of the shell is serr anteriorly and the serrations are irregularly grouped posteriorly between l setae. The post-abdomen has a well marked heel and the dorsal edge has marked serrations (fig. 3) more like those illustrated by Stingelin (1914: fig.

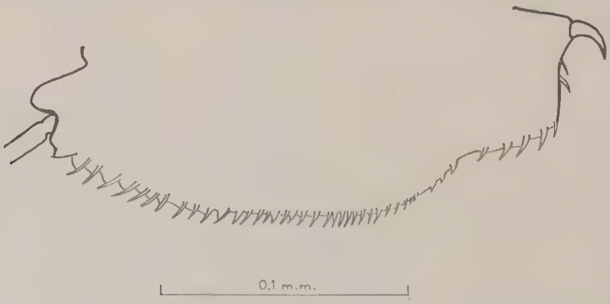


Fig. 3. *Macrothrix triserialis* Brady, post abdomen.

than Harding (1955); there are no lateral spinules on the post-abdomen. antennules are equal in width throughout their length and there are two or th well marked spines at the tip.

Distribution and ecology. Unlike *M. goeldii*, this species nmon in swamp habitats, and it was not recorded from pools by the swamps. was present near Kampala, in the swamps bordering the Nile near the Sudan der and in Teso, but it was absent from Kigezi. It is known from tropical ions in most parts of the world, sometimes from swamp habitats (e.g. in rding, 1957: "exutoire du marais" and "étang marécageux").

Macrothrix goeldii Richard, 1897

lacrothrix goeldii Richard, 1897: 281, figs. 32-34; Harding, 1957: 69, figs. 11-14.
lacrothrix goeldii forme *murati* Gauthier, 1939: 162, figs. 7-8.

dentification. This species is easily distinguished from *M. triserialis*. shell markings are reticulate, and the markings cause minute serrations on the sal margin of the head; the ventral margin of the shell has a few long setae the serrations between the setae are inconspicuous. There is no heel on the t-abdomen, which is relatively short and broad as shown by Harding (1957: 13), but my specimens do not show the groups of spines just dorsal to the claw ch are shown in that figure. The antennule is curved backwards and is rather e than twice as broad at its tip as at its base; there are five or six notches along anterior margin and the fine spines at the tip are not prominent like the stout ies of *M. triserialis*. Length about 0.4 mm, rather smaller than *M. triserialis*.

istribution and ecology. Often found in the pools at the edge of swamps. Always present at Bukasa V and sometimes very abundant there. ient in the lake swamp at Lake Nabugabo, but not in the swamps at the edge he Nile near the Sudan border. It was recorded from Teso, but not in the high ude region of Kigezi.

n these different parts of Uganda small green algal epizoites were associated it. They occurred on the legs and sometimes on the shell, and were so abundant the animal usually looked quite green. The suggestion of a symbiotic relation- between the alga and the cladoceran, by which the alga would supply the gen that would enable the cladoceran to live in swamp conditions, was not sup- ed by the distribution of the cladoceran. It was most common in sunlit pools re the oxygen concentration was probably relatively high, and the cladoceran strongly negatively phototactic. *M. goeldii* was however absent in heavily ed pools. Ephippia were not found.

he species is not well known outside East Africa. It was described from Chile. hier describes a variety from Lake Chad. Harding records it from five stations anganyika and refers to a single record by Gurney from Calcutta.

Guernella raphaelis Richard, 1892

ernella raphaelis Richard, 1892: 6, figs. 4-6.
ernella ceylonica Daday, 1898: 54, figs. 26, 27; Brehm, 1951: 90, fig. 1 q-s; Brehm, 1953: 336

istribution and ecology. *G. raphaelis* is very small and might be overlooked. It occurred in only three places and was never very abundant, but I expect that it may be found to be fairly common in swamp habitats. It present in most of the collections made between January and June in the d beside the path through the swamp at Bukasa, a habitat into which very little l could penetrate through the dense papyrus. All the specimens found were int pink in colour.

One ephippial female was found on the 24th February in the Katonga r swamp, where parthenogenetic females were common. The ephippium was stro reticulated and contained a single egg. No males were found.

Distribution outside Uganda. Records of the genus *Guernella* infrequent. Apart from one record from the Belgian Congo, which Brehm c siders doubtful (Brehm, 1939), the above appear to be the only references.

The genus is very distinctive. The form is clearly that of a Macrothricid, an the family there are only two other genera, *Pseudomoina* and *Lathonura*, v setae on the antennae in the arrangement 0113/113. The very small post-abdom without the marked heel seen in *Lathonura*, and the short thick antennule sepa this genus from the other two (Gurney, 1927).

Brehm (1951) wonders if the two species of the genus should be consid synonymous and says that his specimens from New Guinea on "zoogeograp grounds may be presumed to be identical with *G. ceylonica*" (translation). He on to say that the differences between the species as described by Daday in are "somewhat problematical", and he hopes that "discoveries of new coloni *Guernella* will permit a definitive resolution of the problems of the genus." single female example reported by him in 1953 from Indian collections did permit this resolution.

My specimens which come from Uganda might be expected to belong to same species as those which Richard described from the Congo. But they also the characters which Daday, describing specimens from Ceylon, used to sepa the species *G. ceylonica* from *G. raphaelis* of Richard. These characters are shape of the post-abdomen and the presence of bundles of fine hairs on the s of the post-abdomen. Brehm remarks that the shape of the post-abdomen may be a significant character as it may be altered by the pressure of the coversli the specimen. Richard describes the ventral edge of the post-abdomen as in form of a smooth curve while in Daday's specimens the edge was drawn in form two loops instead of a single curve. I have observed a smooth curve in some s mens and loops in others and therefore agree with Brehm that this character is significant.

Richard comments with surprise on the absence of any spines on the p abdomen of the Congo specimens, but it is possible that he could have overloo the very fine hairs which Daday saw and which I find only just visible with car illumination under a $^{1}/_{6}$″ objective and only a little more distinct under a $^{1}/_{12}$ I cannot determine at which end of the hair is the insertion into the post-abdo and wonder if they are not hairs but artefacts or minute ridges in the surfac the post-abdomen.

he only difference that I can find between my specimens and those described
Daday is the shape of the labrum, a character which is not sufficient to justify
division of the genus into two species. Brehm's description of the New Guinea
imens leaves no doubt that they are similar to mine, and so I consider that all
records refer to the same species which should therefore carry the name which
hard used to honour his two colleagues Jules de Guerne and Raphael Blanchard.

Grimaldina brazzai Richard, 1892

dentification. This large member of the family Macrothricidae, with
stinctive post-abdomen, was identified very easily. There are no other species
he genus.

istribution and ecology. A species characteristic of swamps in all
ons of Uganda except Kigezi. It was usually found among plant debris at the
om of the water, but in aquaria in the laboratory it was seen near the surface.
as found more frequently in swamps than in pools by the swamps, perhaps
ly because some of the collections from pools did not include debris from the
om. As many as 60 per litre were recorded from a region of the Fort Portal
l swamp where there was a thick red flocculent scum and I came to associate
being abundant with this type of scum. In other habitats it was much less
mon. It was frequently associated with *Pseudosida bidentata* and *Moino-*
nia macleayi as is shown in the occurrence of the three species at the twenty-
different places at which at least one of them was present (cf. table VI).

TABLE VI

ciation between Grimaldina brazzai, Pseudosida bidentata *and* Moinodaphnia
eayi *at the twenty-five different places in which at least one of the three was present*

seudosida identata	*Moinodaphnia macleayi*	*Grimaldina brazzai*	*Number of places in which they were found in this combination*
+	—	—	5
—	+	—	4
—	—	+	2
+	+	—	2
+	—	+	4
—	+	+	0
+	+	+	8
			25

phippial females were not found nor were males seen. Sars (1901) gives fig-
of the male which show that it resembles the female very closely. He also
ribed the ephippium.

All the specimens found in Uganda were orange-red in colour and Sars (19 observed that the specimens he had were reddish brown.

Distribution outside Uganda. The species was described Richard (1892) from specimens from the Congo. It is well known in East Af (Daday, 1910; Harding, 1957) but has not been recorded from West Africa (Brehm, 1933). Sars (1901) raised it from dried mud sent to him from Bra and Brehm has recorded it from Brazil, and also from Venezuela. Birge (191 records it in the southern U.S.A. Daday (1910) records it from New Guin Some of these records describe it as occurring in mud, and Sars and Richard m tion it as a bottom-living form. Most of the other records refer to its occurrence marshy or weedy pools.

Conclusion. This is a tropical species which seems to be particularly sociated with swamp conditions. There is no suggestion that it evades conditi of low oxygen concentrations, so study of its physiology would be interesting. is not common but Richard writes of "very large numbers" and I found it abund in a few habitats.

DISCUSSION

These observations show that the species described in detail are characteri of swamps in Uganda. The literature has shown that, with the exception of *G nella raphaelis*, they are well known from pools, swamps and ditches in other p of the tropics. Only *Simocephalus exspinosus* occurs also in temperature regi

The ecology of the Cladocera is not at all well known either in tropical o temperate climates. There are few precise observations about their food, thou Lefèvre (1942) has demonstrated that species of *Daphnia* obtain good nutrit from certain unicellular algae, like *Chlorella vulgaris*, which are small, hav fragile cell-wall and are maintained in suspension in cultures, and that they do survive when fed on closely related algae which have not got these characterist Similarly Van Heyningen (1954) showed that living phytoplankton is much m important as food for Cladocera than non-living detritus. Herbert (1954) carried out experiments on the oxygen requirements of a few species and has sho that species of *Daphnia* which live in ponds can tolerate conditions of lower oxy concentration than those which live in lakes.

But in temperate regions the appearance and disappearance of particular spe often seems fortuitous rather than the product of particular physical, chemical biological factors. The tropics, where temperatures are fairly constant and the sa species is abundant for several months or perhaps for the whole year, may be m satisfactory than temperate regions for the study of the ecology of the Cladoce

Environmental factors which appear to be significant in the ecology of swamp Cladocera are the rate of flow of water through the swamp and the amo of light falling on the surface of the water. The water level changes far more th casual observations led me to expect, and it may fluctuate rapidly. For examp the water level at Namulonge rose ten inches in twenty-four hours and at

mp at mile 7 on the Fort Portal Road, the level rose eight inches and fell back
normal within three days. Observations at this place suggested that *Pseudosida*
ntata was brought into the swamp during flooding, and that it did not survive
e for long.

he amount of light falling on the water was important. Far more Cladocera
e found in regions where the papyrus had been cut than where it was growing
sely; presumably light acted through providing conditions for the algae to
elop and provide food, as well as increasing the oxygen concentration by photo-
hesis. A sunlit pool (Bukasa V) was highly productive and figures for the
ulation density are given here because so few estimates of this nature are
lable. Though different species are involved population density figures from
r regions are given for comparison.

TABLE VII

Numbers of certain Cladocera in 1 litre of water

asa V		*3rd May*	*8th May*
res obtained	*Macrothrix goeldii*	110	320
n fractions of	*Pseudosida bidentata*	32	89
mple of four	*Ceriodaphnia cornuta*	19	164
etfuls (32 litres)	*Ilyocryptus spinifer*	30	57
	Moinodaphnia macleayi	5	24
Plankton			*max. numbers*
k and Rzoska, 1954	*Ceriodaphnia rigaudi*		117
	Diaphanosoma		5
	Moina dubia		2.5
l in English Lake District			*max. numbers*
ly, 1952	*Chydorus sphaericus*		120
	Sida crystallina		20
at Fredericksborg Castle			*max. numbers*
; 1929, quoted by ly, 1952	*Bosmina longirostris*		952
	Chydorus sphaericus		355
	Daphnia cucullata		229

tudy of the habitat suggests that *Ilyocryptus spinifer* and *Grimaldina brazzai*
ld be good species to investigate to see if they show adaptations to life in
mps. *Pseudosida bidentata* is more generally distributed in the tropics and
ably cannot tolerate conditions of a fully developed swamp. *Simocephalus*
inosus is not really characteristic of swamps. The genus *Macrothrix* contains
y species which are not easily distinguished so investigation of their ecology
ht be frustrated by their systematics. It is clear however that *Moinodaphnia*
leayi is able to live in swamps because it avoids the conditions of low oxygen
entration by living just below the surface.

ZUSAMMENFASSUNG

Die Papyrussümpfe werden kurz beschrieben und neun Cladoceren-Arten aus den Sümpfen Ug das gemeldet. Diese Arten sind auch von Sümpfen in anderen Teilen der Welt bekannt. *Mo daphnia macleayi* lebt in den relativ sauerstoffreichen obersten Wasserschichten unmittelbar un halb der Wasseroberfläche. Ein eingehenderes Studium von *Ilyocryptus spinifer* und *Grimald brazzai* würde vermutlich interessante Aufschlüsse liefern über die Physiologie sumpflebender Kre Die Systematik der Gattung *Guernella* wird kurz erörtert.

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CANDACIA KETCHUMI, A NEW CALANOID COPEPOD FROM THE NORTH-WESTERN PART OF THE SARGASSO SEA [1]

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There are presently several investigations at the Woods Hole Oceanographic Institution concerned with the biology and chemistry of marine plankton, one of which is the analysis of zooplankton samples. These samples are obtained periodically from a series of collecting stations extending from the coastal waters off New York to Sargasso Sea waters near Bermuda. The new copepod described herein was found while examining certain of the Sargasso Sea collections.

Seven described species of *Candacia* have to date been found in these samples. *C. armata* (Boeck) has been observed primarily in collections from stations situated in continental shelf and slope waters. *C. curta* (Dana) has been detected only in Gulf Stream samples. *C. aethiopica* (Dana), *C. bispinosa* (Claus) and *C. simplex* (Giesbrecht) have appeared in one sample from a station located on the seaward side of the continental shelf-edge and in several collections from the Gulf Stream and Sargasso Sea. *C. longimana* (Claus) and *C. pachydactyla* (Dana) have been observed in Sargasso Sea samples and the latter species from Gulf Stream samples as well. With the exception of *C. aethiopica* these species have all been reported recently from the southern Atlantic coast of the United States and all but *C. aethiopica* and *C. armata* from the Gulf of Mexico (Fleminger and Bowman, 1956). *C. aethiopica*, *C. bispinosa*, *C. longimana* and *C. simplex* have previously been recorded from the Sargasso Sea near Bermuda (Wilson, 1936; Moore, 1949).

In addition to the above seven species the following have been reported from the indicated areas, adjacent to the Atlantic coast of North America: *C. bipinnata* (Giesbrecht) and *C. paenelongimana* Fleminger and Bowman from the Gulf of Mexico and southern Atlantic coast (Fleminger and Bowman, 1956); *C. norvegica* (Boeck) from off Georges Bank (Bigelow, 1926) and from southeast of Nantucket Island (Wilson, 1932); *C. elongata* (Boeck) and *C. falcifera* Farran from the Labrador Sea area (Jespersen, 1934) and *C. varicans* (Giesbrecht) from the waters south of Nova Scotia (Willey, 1919). Wilson (1932) also reported *C. armata* and *C. pachydactyla*, Jespersen *C. norvegica* and Willey *C. armata*, *C. bipinnata* and *C. simplex*.

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ncluding the new copepod described below there is thus a total of 14 species *Candacia* known to occur in the northwest Atlantic Ocean. This new copepod named in honor of Dr. Bostwick H. Ketchum, Senior Oceanographer, Woods le Oceanographic Institution.

Candacia ketchumi n. sp. (figs. 1-21)

ocalities and materials. — 34°47'N. 66°30'W., R. V. Crawford Cruise 35, station , December 16, 1959, 200-0 m depth of tow, 1 female — 36°23'N. 68°08.3'W., R. V. Crawford ise 38, station 799, March 17, 1960, 200-0 m depth of tow, 1 female, 1 male.

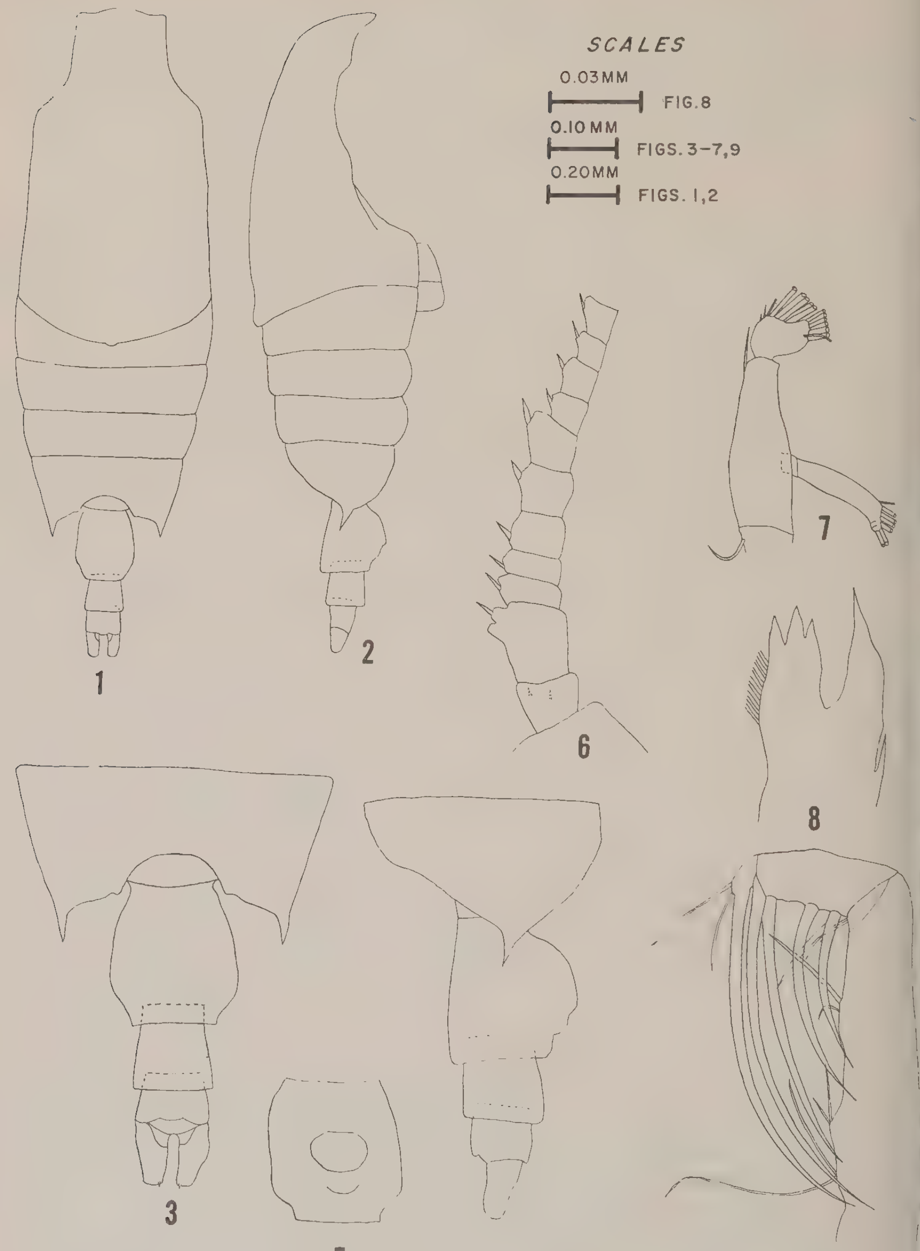
ypes — Type material has been deposited in the U. S. National Museum as follows: female otype (U.S.N.M. no. 105026) and male allotype (U.S.N.M. no. 105027) from Cruise 38 and emale paratype (U.S.N.M. no. 105028) from Cruise 35.

Measurements — Total length measurements were made from the an- or tip of the head to the end of the furca and do not include that length of abdominal segments which was telescoped. The telescoped length was in- ded in the measurements from which the relative proportions of the abdominal ments were computed.

Description — Female (figs. 1-15). The general shape of the body embles that of other species of *Candacia*. In dorsal view the anterior end of head is truncate, segments 4 and 5 of the thorax are fused, and the posterior ners of the fifth thoracic segment end in symmetrical points (fig. 1). In eral view there is a knob-like protuberance on the dorsal surface of the head a point where it joins the first thoracic segment (fig. 2). The rostrum-like ensions of the antero-ventral surface of the head are thick and conspicuous. The abdomen has 3 segments (figs. 3, 4). The genital segment is slightly mmetrical as seen in dorsal view (fig. 3). In ventral view (fig. 5) there is mall, rounded protuberance situated a short distance anterior to the posterior rgin of the segment. The pre-anal and anal segments are symmetrical and their nbined lengths are approximately equal to the length of the genital segment. e abdominal segments and furca of the paratype have the following propor- ns: 40, 26, 15, 19 = 100. The cephalothorax-abdomen ratio of this speci- n is 3.2 : 1 and the total length is 1.80 mm. Total length of the holotype .75 mm.

When held against the body the first antennae reach to approximately the end the furca. The proximal 7 segments are enlarged and each except the first ment is furnished with a stout marginal spine (fig. 6). This segment has 2 all spines which arise from the ventral surface.

The second antenna (fig. 7) has a 2-segmented exopod and 2-segmented en- od. The proximal segment of the endopod is fused with the second basal ment. There are 7 setae on the distal end of the exopod, the proximal one of ich is slender. The outer lobe of the endopod has 6 setae and another smaller a arising from the inner surface. The inner lobe has 5 large setae, 1 small a, and 2 minute setae.


SCALES
0.03MM
FIG.8
0.10MM
FIGS. 3-7,9
0.20MM
FIGS. 1,2
1
2
6
7
8
3
5
4
9

Figs. 1-9. *Candacia ketchumi* n. sp. 1, female, dorsal view. — 2, lateral view. — 3, fourth ar fifth thoracic segments and abdomen, dorsal view. — 4, fourth and fifth thoracic segments ar abdomen, lateral view. — 5, genital segment, ventral view. — 6, proximal 11 segments of fir antenna. — 7, second antenna. — 8, gnathal lobe of mandible. — 9, second maxilla.

There is a tricuspate basal tooth on the gnathal lobe of the mandible (fig. 8). he exopod has 5 and the endopod 6 setae.

The first maxilla is like that figured for C. *norvegica* (Boeck) by Grice and nes (1960).

The second maxilla (fig. 9) is large and has 4 groups of small spines and ae on the first basipodal segment. There are 2 large spines on the second sipodal segment, the proximal one of which is shorter than the distal one. hree very large spines are present on the endopod. Of these the middle spine the longest and the proximal spine is the shortest.

The maxilliped is small and similar to that found in other species of *Candacia.* he first basal segment is long and has 1 seta arising from the approximate mid-int and 1 long and 1 short seta arising from the disto-lateral corner. There 3 setae near the distal end and a row of short hairs on the proximal end of e second basipodal segment. The endopod consists of 5 segments all of which ve 2 setae excepting the first which has 3 setae.

The swimming feet have 3-segmented exopods and 2-segmented endopods igs. 10-14). The lengths of the third exopodal segment of swimming feet to 4 have the following relation to that of their respective terminal spines: : 1.1, 1 : 0.8, 1 : 0.6, 1 : 0.8. The terminal spine on the third foot is bent at tip and has small teeth-like structures extending onto the curved, distal portion ig. 13).

The fifth pair of feet (fig. 15) are short and terminate in 2 sub-equal spine-e processes. Two small spine-like points are on the outer and 3 setae on the ner margin of the distal segment. There is a small seta on the outer, disto-eral corner of the penultimate segment.

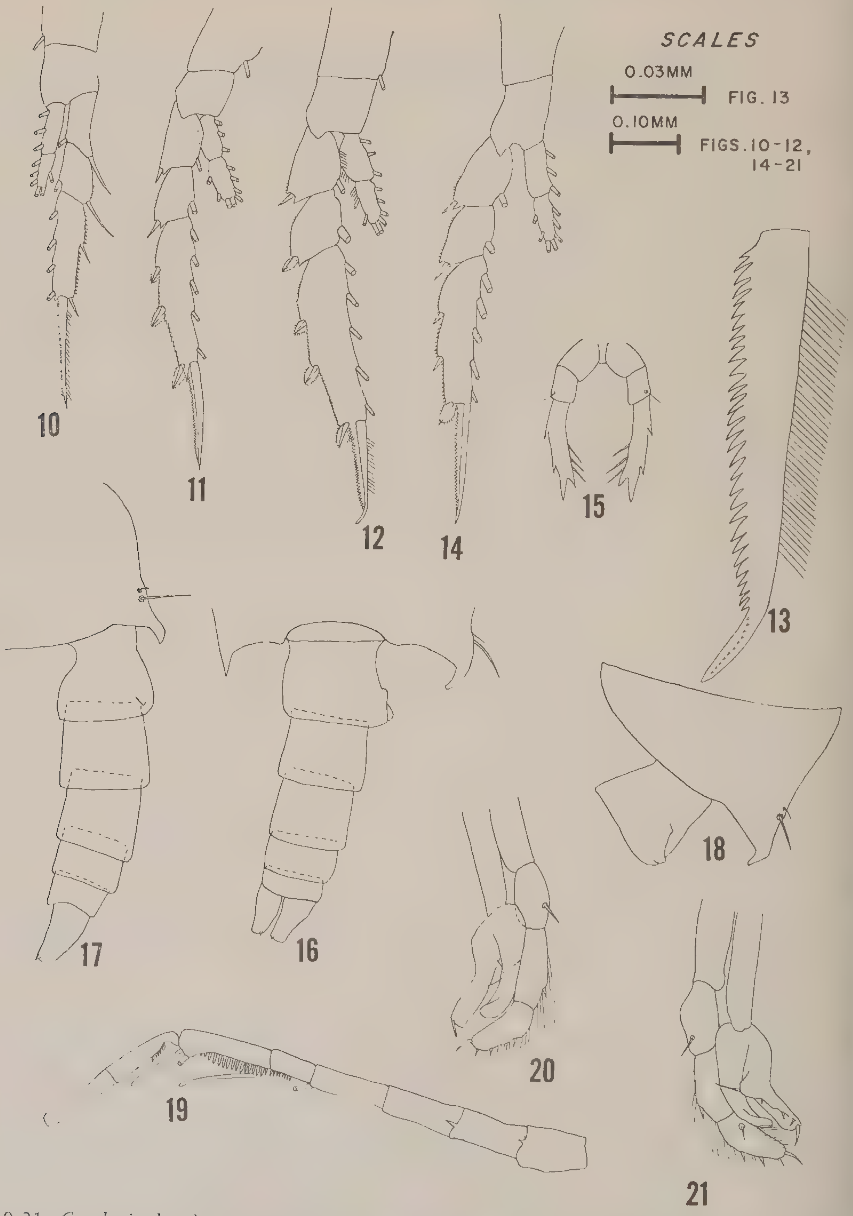
Male (figs. 16-21). The cephalothorax-abdomen ratio is 3.2 : 1 and the relative ngths of the abdominal segments and furca are as follows: 24, 20, 22, 13, 13 = 100. These figures are based on measurements of the allotype, the total ngth of which is 1.75 mm.

The posterior lateral processes of the fifth thoracic segment are asymmetrical. he one on the right is pigmented, thickened and turned inward in dorsal view ig. 16). In lateral view (fig. 17), the distal end is turned upward. The process the left side resembles that of the female.

A small, elongate process is present on the right lateral margin of the genital gment (fig. 16). In lateral and oblique views (figs. 17, 18), the process pears to be diagonally oriented across part of the posterior end of the segment.

Segments 13 and 14 of the right first antenna have a small spine-like process the distal margin, and segments 17, 18, and 19 have a row of teeth along e lateral margin (fig. 19). The teeth on segment 18 are coarse and extend r most of the length of the segment. Teeth on segment 17 are situated along e distal half of the segment, while those on segment 19 are limited to the oximal third of the segment. On these latter 2 segments the teeth are fine.

The right and left fifth feet are approximately equal in length (figs. 20, 21), the former being chelate. There are 2 small spines near the distal end of the finger of the chela and the raised internal margin has 1 long and 2 short spines,


SCALES
0.03MM
FIG. 13
0.10MM
FIGS. 10-12, 14-21
10
11
12
14
15
13
17
16
18
20
19
21

Figs. 10-21. *Candacia ketchumi* n. sp. 10, female, first foot. — 11, second foot. — 12, third foo — 13, terminal spine of third exopodal segment of third foot. — 14, fourth foot. — 15, fift feet. — 16, male, abdomen, dorsal view. — 17, abdomen, lateral view. — 18, fourth and fift thoracic segments and genital segment, oblique view. — 19, segments 13 to 20 of right firs antenna. — 20, fifth feet. — 21, fifth feet, other side. Figs. 1-15 drawn from paratype; figs 16-2 drawn from allotype.

e thumb of the chela is short and naked. The terminal segment of the left fifth ot has 4 marginal and 1 surface spines.

Remarks — This species closely resembles *Candacia norvegica* (Boeck) t: the two may be distinguished in a number of ways. In the female, *C. ketchumi* ks the spines which are present on the sides of the genital segment of *C. rvegica.* The 2 spines on the second basipodal segment of the second maxilla *C. norvegica* as figured by Sars (1903) and Grice and Jones (1960) are sub-ual, while in *C. ketchumi* the proximal one is distinctly shorter than the distal e. The fifth pair of feet of *C. ketchumi* lack the seta on the inner, disto-lateral ner of the penultimate segment.

In the male, the two species are most easily separated by the form of the ocess on the right side of the genital segment. In *C. norvegica* this process is ite large and has an irregular, lobiform tip. In *C. ketchumi* it is small and rcely visible in dorsal view.

The two species also differ in size and probably in distribution. North At-tic specimens of *C. norvegica* are approximately 3.2 mm in total length arran, 1948) whereas Sargasso Sea specimens of *C. ketchumi* are less than 0 mm. The former species apparently occurs in waters colder than those in ich the latter species has so far been found (approximately 18°-22°C).

ZUSAMMENFASSUNG

eschreibung der *Candacia ketchumi* n. sp. anhand von Exemplaren aus der nordwestlichen gasso See. Es ist bekannt, dass dreizehn andere Arten der Gattung *Candacia* im nordwestlichen antik vorkommen.

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MICROTHAMBEMA TENUIS N. GEN., N. SP. (ISOPODA ASELLOTA AND RELATIONS OF SOME ASELLOTE ISOPODS

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During the expeditions of the Soviet research vessel "Vitjaz" in the Nort western Pacific many deep-sea Isopods mainly belonging to the suborder Asello were collected. Among them one species presents a great interest. This speci must be assigned to a new genus closely related to the genera *Thambema* Stebbin *Microparasellus* Karaman, *Microcharon* Karaman, *Angeliera* Chappuis and Del mare (= *Brevipleonida* Gnanamuthu), *Microjaera* Bocquet and Lévi, *Mackin* Matsumoto, *Caecianiropsis* Menzies and Petit, *Protocharon* Chappuis and De mare and probably too to the genus *Ectias* Richardson.

Microthambema new genus

Definition. Body extremely slender. Head with round prominent fron area. Eyes absent. First antenna short, with 6 segments. Second antenna lon than head, multiarticulated, squama lacking. Mandibles normal, molar proc well developed and truncated at apex, lacinia present on left mandible, palp segmented. Maxilliped with 2 coupling hooks. Maxillipedal palp 5-segment the first three segments expanded, wider than endite. All peraeon somites fr Peraeon somite 1 shorter than all others, peraeon somites 4-7 elongated. Peraeop 1 prehensile, the last six peraeopods of moderate length, their dactyli with o claw. Carpus of peraeopods 2-4 expanded. Pleon consists of two movable somit Pleotelson elongated, oval, with rounded posterior margin. Pleopods 1 and normal, pleopods 3 and 4 uniramous. Uropods biramous, with peduncle, ex podite short.

Type species: *M. tenuis* n. sp.

Microthambema tenuis new species (figs. 1, 2)

Material: One male, 2.7 mm long and 0.32 mm wide at first peraeonal somite; "Vitja station No. 3886, 31°11.0′ N. 143°09.7′ E., depth 5680-5690 m.

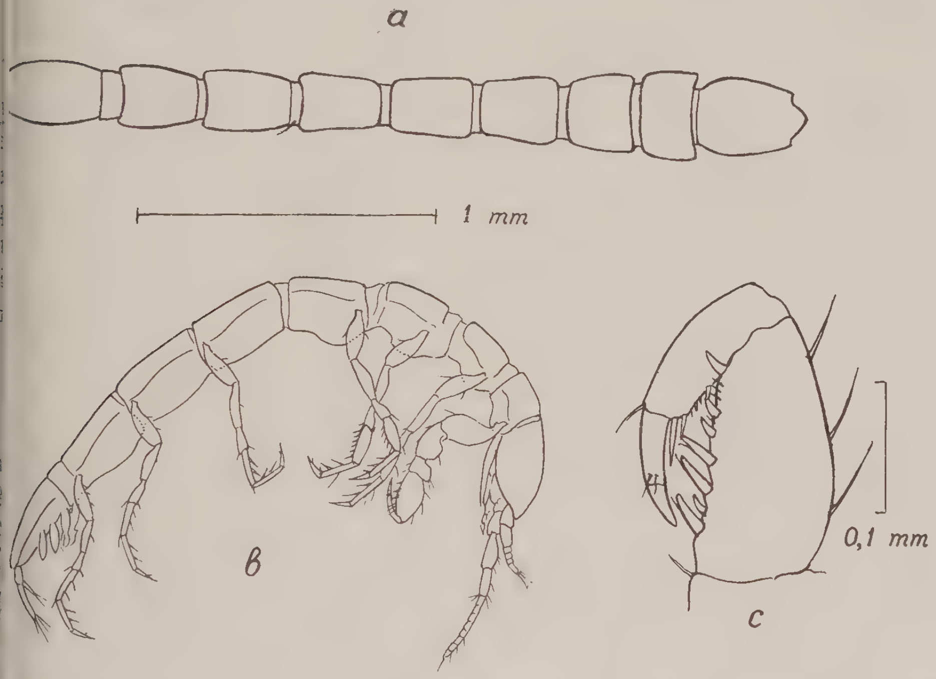
Description: Body elongated, 8.5 times longer than broad (width peraeon somite 1).

Head longer than broad, protruding between the antennae into a semicircu lobe. Eyes lacking.

Peraeon somites 1-3 increase in length but decrease in width from 1 to 3. nterior margin of these somites broader than the posterior. Peraeon somites -7 equally long, each somite 1¾ as long as somite 1, anterior margin narrower ıan posterior.

Pleon consists of two movable somites, the first narrower and only 1/6 as long the second. The second somite oval, 1¾ as long as broad, with semicircular osterior margin, longer than each of the posterior peraeon somites.

First antenna (fig. 2a) shorter than head, consists of six segments. The second

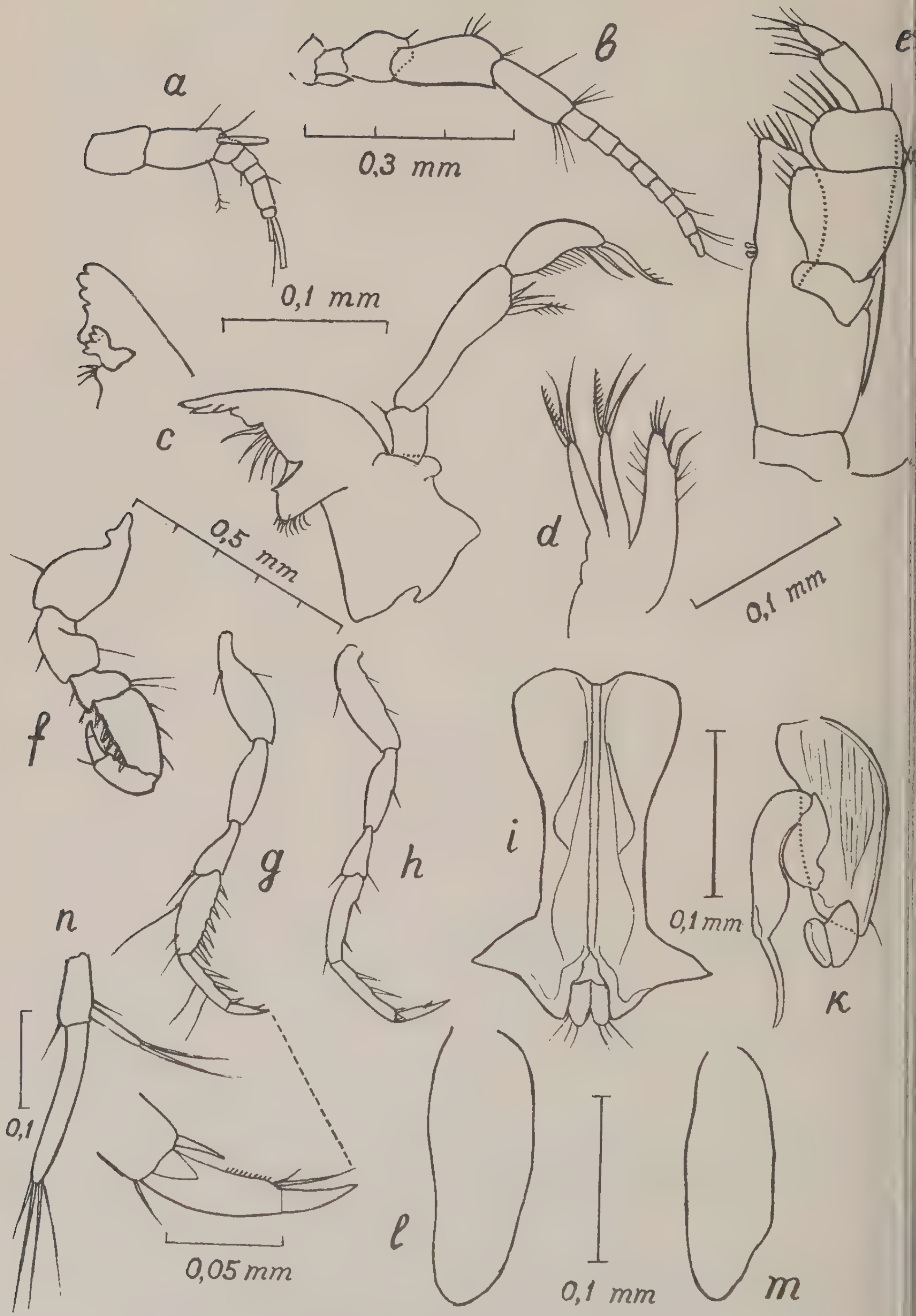


g. 1. *Microthambema tenuis* n. gen., n. sp. a, in dorsal view; b, in lateral view; c, terminal part of peraeopod 1.

gment is 1½ times longer than the first. Second and last segments furnished ith one large sensory filament.

Second antenna (fig. 2b) twice as long as the first antenna. The first three gments of peduncle short, the fourth slightly shorter than the fifth; the fifth ıd sixth segments subequal in length, but the last somewhat broader. The 8-gmented flagellum about as long as the last two segments of the peduncle gether.

Right mandible (fig. 2c) has a cutting edge with five blunt teeth. Five spines the spine-row. Molar process strong, sub-cylindrical, the three-segmented palp ell developed, with strongly curved terminal segment. Left mandible with cutng edge like that of the right mandible, spine-row consists of three spines only, e movable lacinia short, with four teeth.


a
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e
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Fig. 2. *Microthambema tenuis* n. gen., n. sp. a, first antenna; b, second antenna; c, right and le mandible; d, second maxilla; e, maxilliped; f, first peraeopod; g, second peraeopod; h, sevent peraeopod; i, first pleopod; k, second pleopod; l, third pleopod; m, fourth pleopod; n, uropo

Maxilla 1 and 2 (fig. 2d) typically shaped, as in *Thambema amicorum* Stebbing.

Maxilliped (fig. 2e) like that in *Th. amicorum,* with two coupling hooks, ut the epipodite longer than in *Th. amicorum,* reaching the distal margin of he endognath. Palp 5-segmented, in its broadest part 1½ times wider than the ndite.

Peraeopod 1 (figs. 1c, 2f) stouter but shorter than other peraeopods. Basis, schium and merus much expanded distally. Carpus narrows distally, twice as ong as its greatest width, with seven stout unequal spines on the lower margin. ropodus slightly curved, shorter than carpus, dactylus 1½ times shorter than he carpus.

Peraeopods 2 (fig. 2g), 3 and 4 subequal in shape and size. Basis longer han each of the succeeding segments, expanded at the middle. Ischium and erus almost equally long, ischium with six to seven spines, merus with two pines along the anterior convex margin. Propodus shorter than merus and schium.

Peraeopods 5, 6 and 7 (fig. 2h) almost as long as the preceding peraeopods ut basis more elongated and carpus more slender. No spines along the anterior argin of carpus. All dactyli provided with one claw.

Pleopod 1 (fig. 2i) in general form similar to that of an anchor. The base ounded, the outer distal corners protruding outwards in triangular lobes. The ndopodites slightly projecting and furnished each with three hairs.

Pleopod 2 (fig. 2k) like in *Thambema amicorum* but endopodite considerably onger. Exopodite two-segmented. Sympodite with one hair at the inner distal orner.

Pleopods 3 and 4 (figs. 2l, 2m) uniramous, oval.

Uropod terminal, shorter than pleotelson. Exopodite almost as long as pedun- e, endopodite three times longer and broader than exopodite.

SYSTEMATIC POSITION

Though *Microthambema tenuis* n. sp. has many features in common with *hambema amicorum* Stebbing, a complete comparison of these species presents me difficulties because the description given by Stebbing (1913) is not quite rrect, as has been already pointed out by Bocquet and Lévi (1955) and Men- es and Petit (1956).

Thus the uropods of *Th. amicorum* are probably broken off, not lacking, as ought Stebbing (Bocquet and Lévi, 1955), and the pleon consists of two so- ites rather than of one, as described by Stebbing (Menzies and Petit, 1956); deed a slight indication of a first free somite can be discerned on the figure ven by Stebbing himself (plate 26). Furthermore the maxillipedal palp of *h. amicorum* is not four-segmented, but five-segmented. Here too our statement confirmed by the figure of Stebbing, showing the beginning of a suture between e first and the second segments. If these corrections are accepted the close relation of *Microthambema tenuis* and *Thambema amicorum* becomes quite evide

The two genera are similar in respect to the form of body, head and ple telson; the structure of all appendages is very similar too, with the exception pleopods 1, 3 and 4 (the structure of the uropods of *Th. amicorum* is as y unknown). The difference between the pleopods 1 is a minor one: in *Th. ami corum* the exopodites of the pleopod 1 are less expanded distally and the endo podites are much longer and protrude farther out of the incisure of the dist margin of the exopodites as compared with *M. tenuis*. The difference in structu of pleopods 3 and 4 is essential: they are biramous in *Th. amicorum* and uniramo in *M. tenuis*. Due to these differences the species considered must be referr to different though closely related genera.

They are nearer to one another than either of them to any other genus. Fro all the genera listed above, which resemble *Thambema* and *Microthambema* their slender body and well developed first abdominal somite *Th. amicorum* a *M. tenuis* differ by a strong prehensile first peraeopod and the presence of o claw on the dactyli of the other peraeopods, as well as by a longer epipodite of t maxilliped, extending beyond the second segment of the palp.

The position of these two genera as well as of the related genera *Micropa sellus, Microcharon, Angeliera, Microjaera, Mackinia, Caecianiropsis. Protochar* in the system of the suborder Asellota still remains obscure.

Bocquet and Lévi (1955), who did not recognise the Microparasellidae Karam as a self-contained family, suggested that the genera *Microparasellus, Microchar Angeliera* and *Brevipleonida* referred to this family should be assigned, togetl with the new genus *Microjaera* and, possibly, the genera *Thambema* and *Ect* to a new subfamily Microjanirinae, which, in their opinion, belongs to the fam Janiridae. They regard the tendency to a reduction of respiratory pleopods as essential distinguishing character of the Microjanirinae.

Chappuis (1959) in his critical analysis points out a basic difference between t Microparasellidae and the Janiridae, namely the structure of the mandibular mol process, cone-shaped in the Microparasellidae and subcylindrical in the Janirid As to the tendency to a reduction of respiratory pleopods Chappuis associates th feature with the small size of the animals that makes integumentary respirati possible. This statement of Chappuis is confirmed by the material studied by u the respiratory pleopods of the small *Microthambema tenuis* are far more reduc than those of the larger *Thambema amicorum*.

According to Chappuis the genera *Microparasellus, Microcharon* and *Angeli* (= *Brevipleonida*) belong to the family Microparasellidae, whereas the gene *Caecianiropsis* and *Microjaera* must be assigned to the family Janiridae; th systematic position of the genera *Mackinia* and *Protocharon* remains unknow the genus *Ectias* has to be considered incertae sedis. No mention is made by th author of the genus *Thambema*.

Not all of these statements seem convincing. Thus the genera *Microjaera* an *Caecianiropsis,* though possessing well-developed mandibular molar processes ca not be included into the family Janiridae because of their relatively large free first abdominal somite, never encountered in genera of the family Janiridae but inherent to the family Microparasellidae. This primitive character connects the genera *Microjaera, Caecianiropsis, Thambema, Microthambema,* all the Microparasellidae and *Protocharon.*

In regard to *Mackinia,* Matsumoto (1956) who has described this genus, does not indicate in his text the number of pleonal somites, though in his drawing two free somites are represented before the pleotelson. The attribution of *Mackinia* to the Paraselloidea is obvious and is accepted by Matsumoto too, but as no representatives of this superfamily are known to possess a three-segmented abdomen, which is characteristic of the superfamily Aselloidea, it must be surmised that an error has been committed in the figure given by Matsumoto and that in reality *Mackinia,* like all other genera mentioned above, has but one free abdominal somite before the pleotelson.

A second character which prevents the inclusion of *Caecianiropsis,* as well as of *Protocharon, Mackinia* and all the Microparasellidae into the family Janiridae is the structure of the first pair of peraeopods which in all these genera is like or nearly like that of all other peraeopods. In this respect *Microjaera* is near to the Thambematidae and most Janiridae, though among the latter representatives are known with an undifferentiated peraeopod 1 (as for instance *Jaera*).

Such features as body form, the presence of a well developed first free abdominal somite and the number of claws on the dactyli of peraeopods 2-7 must be regarded as more important distinguishing characters than the form of the mandibular molar process, the more so that even among the typical Janiridae one finds representatives with a cone-shaped rather than a cylindrical molar process, as for instance in the genus *Katianira* Hansen.

Consequently the genera considered here, characterised by the presence of a first free abdominal somite and a slender elongated body, may be grouped into three families:

I. Thambematidae Stebbing. Peraeopod 1 prehensile, differing sharply from the others. Dactyli of peraeopods 2 to 7 with one claw. Mandibular molar process subcylindrical. *Thambema* Stebbing and *Microthambema* n. gen.

2. Microparasellidae Karaman. Peraeopod 1 not prehensile, similar in structure to all the others. Dactyli of peraeopods 2 to 7 with 2 to 3 claws. Mandibular molar process conical or reduced. Pleopod 1 of the male broader at the base than distally. *Microparasellus* Karaman, *Microcharon* Karaman and *Angeliera* Chappuis and Delamare.

3. Microjaniridae Bocquet and Lévi (new combination). Peraeopod 1 slightly differentiated or not differentiated. Dactyli of peraeopods 2 to 7 with 2 claws. Mandibular molar process subcylindrical. Pleopod 1 of the male narrower at the base than distally (with the exception of *Mackinia*). *Microjaera* Bocquet and Lévi, *Caecianiropsis* Menzies and Petit, *Protocharon* Chappuis and Delamare and *Mackinia* Matsumoto.

All three families are closely connected with the family Janiridae, though e
of them by different characters. The family Thambematidae is similar to
Janiridae by their prehensile peraeopod 1 but differs by the dactyli of all ot
peraeopods. Contrariwise the Microjaniridae and the Microparasellidae, resembl
the Janiridae in respect to the structure of dactyli of peraeopods 2 to 7, differ
their peraeopod 1 being not prehensile. However, the Microparasellidae differ fr
most Janiridae by the structure of mandibular molar process.

According to Menzies (1956) the new family Echinothambemidae, which
has described from the Puerto-Rico trench, is near to the Thambematidae. It see
to me, however, that these families are distant from one another, since in
Echinothambemidae the posterior thoracic somites are fused together and w
both the abdominal somites; they have no mandibular palp and are characteri
by a peculiar structure of the first antenna, single-segmented uropods, etc. T
Thambematidae by their characteristic features are nearer to the Janiridae, Mic
parasellidae and Microjaniridae than to the Echinothambemidae.

The well-developed free first abdominal somite, inherent to the Thambe
tidae, Microparasellidae and Microjaniridae, distinguishing them from the Ja
ridae, can be considered a primitive character, indicative of a close relation betw
these three families. It is highly probable that they have retained this featu
associated with acute bending of the body, owing to their mode of life in ca
laries between soil particles. We are as yet entirely ignorant of the mode of
of the abyssal Thambematidae, but it may be inferred from their body fo
similar to that of the Microparasellidae and Microjaniridae, that they too live
capillaries between soil particles.

DISTRIBUTION

The families Microparasellidae and Microjaniridae in the sense suggested
this paper have a similar distribution. Representatives of both families are kno
from interstitial fresh and marine shallow waters.

Among the three genera of the family Microparasellidae the genus *Micropa*
sellus with its two species occurs solely in fresh subterranean waters of Jugosla
and North Africa. The genus *Microcharon* (identical with the genus *Dusle*
Lévi — see Birstein, 1952 and Chappuis and Delamare, 1954) included 10 spec
from fresh interstitial waters of Jugoslavia, Rumania, Hungary and Corsica a
3 marine shallow water psammophile species found in the English Channel
Plymouth and on the Mediterranean coasts of Italy and France (Chappuis a
Delamare, 1954; Spooner, 1959; Karaman, 1959). And finally the genus *Ang*
liera, with two species, occurs in fresh, brackish and marine interstitial waters
South France and Italy and in marine interstitial waters of India (Schulz, 19
Gnanamuthu, 1954).

The family Microjaniridae includes four genera. Among them, the monoty
genera *Microjaera* and *Caecianiropsis* are recorded from marine shallow wat

of France and California, the monotypic genus *Mackinia* and the genus *Protocharon,* with two species, inhabit fresh interstitial waters of Japan, of Réunion Island and of Amsterdam Island.

A characteristic feature of both families under consideration, besides their being confined to marine and fresh interstitial waters, is the discontinuity of the ranges of distribution of certain genera. Thus for instance the genus *Angeliera* is known from France, Italy and India, the genus *Protocharon* from two oceanic islands Réunion and Amsterdam, very distant from one another, the genus *Microcharon* occurs not only on the European continent but also on the Mediterranean islands Corsica and Leucas, the genus *Microparasellus* on the Balkan Peninsula and in North Africa. Such a pattern of distribution is indicative of the great antiquity of these genera.

The family Thambematidae in contrast to the Microparasellidae and Microjaniridae is restricted to the abyssal. *Thambema amicorum* Stebbing was found in the North Atlantic (54°33′ N, 10°56′ W) at a depth of 2490 m and *Microthambema tenuis* n. sp. in the northwestern Pacific (31°11.0′ N, 143°09.7′ E) at 5680-5690 m.

If on the basis of the similarities described above, and, above all, on the presence of a well-developed first abdominal somite, these three families can be considered being closely related and primitive, a fairly accurate notion is obtained of the range of distribution of this group of Isopoda. This archaic group inhabits at present on the one hand fresh and marine interstitial waters, and on the other great oceanic depths.

A similar distribution is observed in some other archaic crustaceans, in particular in the amphipods of the suborder Ingolfiellidea. Three species are known from interstitial fresh waters of Jugoslavia, one species from the caves of the Congo, one shallow-water marine species lives among corals in the Gulf of Siam, and, finally one abyssal species was found in Davis Strait in a depth of 3521 m. Concerning this type of distribution of the Ingolfiellidea Karaman (1959a) writes as follows: "Diese sonderbare Verteilung der Ingolfielliden auf vier Kontinente, überall in nur je einer Art, lässt vermuten, dass es sich um sehr alte, archaische Formen handelt, von welchen jede, als Relikt vergangener Zeit, wohl ein grösseres Areal der Verbreitung besitzen wird" (63).

Recently *Ingolfiella* was found in shell gravel off Plymouth from a depth of 42-48 m (Spooner, 1959a) and in interstitial cavities in rocky bottom on the coast of Peru (Siewing, 1959). These findings emphasize the similarity between the distribution of the group of genera of small Asellota considered here and that of the Ingolfiellidea.

Discussing the causes of the proximity of abyssal and shallow-water faunas, Siewing (1959) admits that: "... flockige Detritus kann möglicherweise in ruhigem Wasser ein ökologisches Aequivalent zum Sandbiotope bilden. Solche Stillwasserzonen werden in grösseren Tiefen häufiger sein als in Flachwassergebieten..." (102).

It must, however, be kept in mind that this similarity cannot be expla merely by ecological factors. The explanation of Siewing does not apply fo stance to the isopod genus *Janirella* (which is now assigned to a special fa Janirellidae, cf. Menzies, 1956), whose distribution is alike to that of Ingol lidea and Thambematidae-Microparasellidae-Microjaniridae. The genus *Jani* includes seven deep-sea species from the North Atlantic, seven still undescr deep-sea species from the North Pacific and one fresh-water species prob subterranean from Victoria. Nevertheless, *Janirella* with their flattened short b cannot be referred to the "Mesopsammal" and their life-habits are probably ferent from those of the Ingolfiellidea and the group of isopod families sidered in this paper. To explain such a pattern of distribution not only ecolog but historical factors, too, must be taken into account as has been emphasise Karaman (*loc. cit.*) in respect to the Ingolfiellidea.

The connection between the deep-sea oceanic fauna on the one hand and interstitial freshwater and shallow marine fauna on the other, is of great sig cance to the controversial question on the age of the abyssal marine fauna. Gr where such connections are known to exist can be considered relicts of anc faunas, once far more widely distributed. This lends strong support to the ception of the presence of many archaic elements in the deep-sea fauna (Ze vitch and Birstein, 1960) and contradicts the idea of its geologically recent mation (Menzies and Imbrie, 1958).

ZUSAMMENFASSUNG

Aus dem nord-westlichen Pazifik aus der Tiefe von 5680-5690 m wird die neue Art Gattung *Microthambema tenuis* beschrieben. Diese Art steht *Thambema amicorum* Stebbing grossen Tiefen des Atlantik nahe. Die Ähnlichkeit zwischen den Thambematidae und zwei A familien mit interstitiellen marinen und limnischen Vertretern (Microparasellidae, Microjaniri legt die Vermutung nahe, dass eine Verwandtschaft zwischen einigen Komponenten der Tie fauna und der interstitiellen marinen und limnischen Fauna existiert, was auch durch die breitung der Ingolfielliden (Amphipoda) bestätigt wird. Diese Verbreitung entspricht der stellung vom Altertum und Archaismus eines gewissen Teiles der Tiefseefauna.

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ON THE NATURE OF THE BASIS IN CERTAIN SPECIES OF THE *HEMBELI* SECTION OF *CHTHAMALUS* (CIRRIPEDIA, THORACICA)

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INTRODUCTION

Recently Dora P. Henry (1957) described an interesting new species of *Chth* *malus* from the Tuamotu Islands in the Pacific. This barnacle, *Chthamalus ca* *careobasis,* is remarkable for its possession of a true calcareous basis, a featu which, according to Henry, separates it from all other members of the genu On the other hand, *C. hembeli* (Conrad), a much larger and closely relat species, is described by Darwin (1854) as having a false basis, one formed an inflection and confluence of the parietes. In a preliminary study of *C. hembe* I examined a juvenile specimen which lacked an inflected parietal wall, but th had a true calcareous basis; that is, a layer of calcareous material covering t entire substrate beneath the barnacle and separated from the parietes by a co tinuous suture around its perimeter. In this, *C. hembeli* is quite similar to t description of *C. calcareobasis.* This, plus other similarities, led me to belie that Henry had in fact described the juvenile form of *C. hembeli* as *C. calcare* *basis,* and that the remaining differences between the two might be attribut to geographic variation.

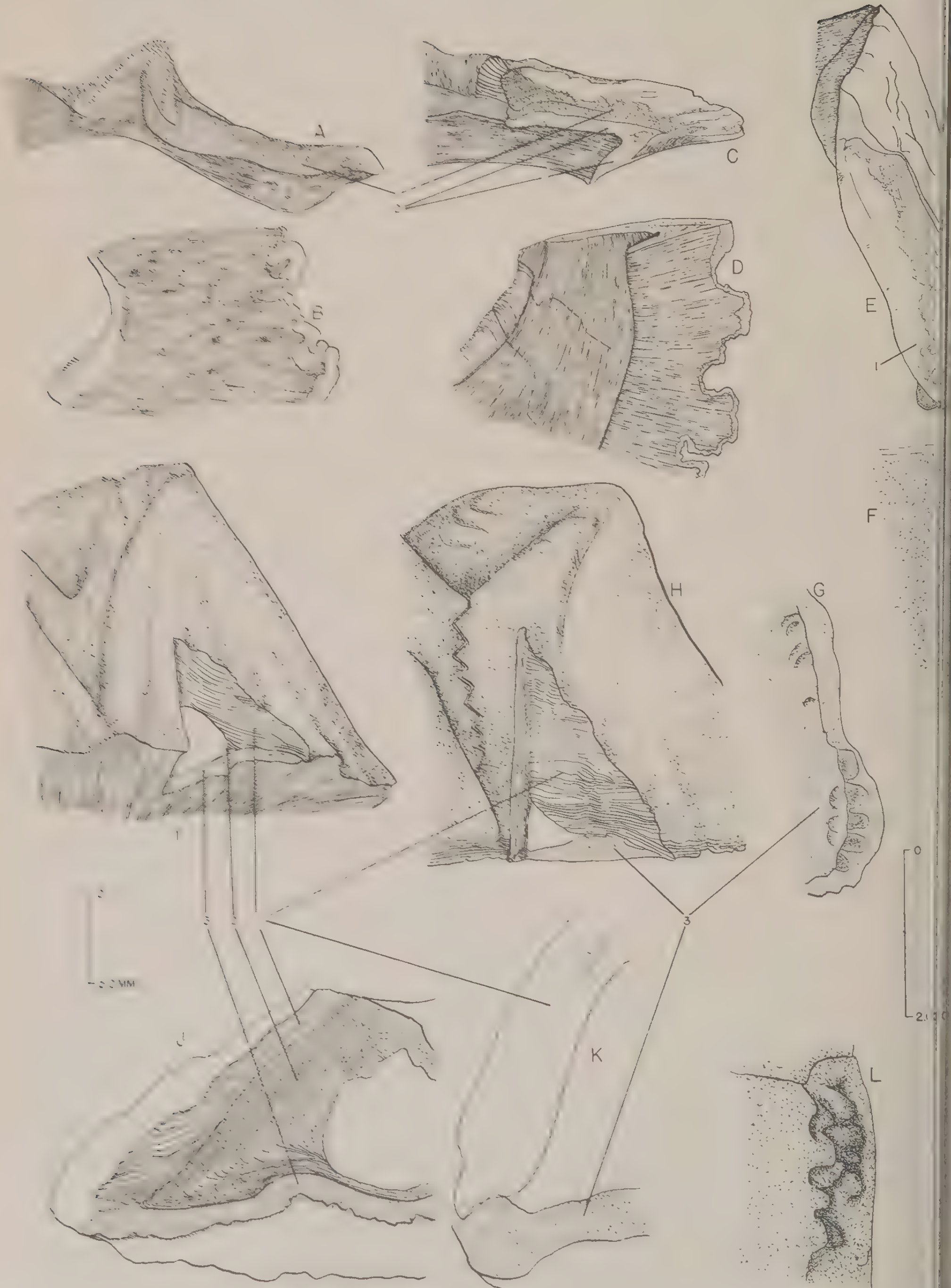
Paratypes of *Chthamalus calcareobasis* and a single large specimen of *C. hembel* both identified by Henry, were obtained on loan from the United States Nation Museum. Dr. Fenner A. Chace, Jr. kindly granted permission to grind the she and to make a preparation of the appendages of one specimen of *C. calcareobas* and to grind the shell of the specimen of *C. hembeli.* Also available for stu were several specimens of the related *C. intertextus* Darwin, 1854, collected Dr. Cadet Hand at Kapingamarangi Atoll, and two large specimens of *C. hem* *beli,* presumably from Hawaii, kindly lent me by Victor Zullo of the Paleo tology Department of the University of California at Berkeley. One of the latte specimens had the juvenile *C. hembeli,* discussed above, on its shell. The ensuin investigation has shown that the initial interpretation, that *C. calcareobasis* re presented the juvenile form of *C. hembeli,* was wrong; *C. calcareobasis* is indee a good species, clearly distinct from juveniles of *C. hembeli.* However, the forme cannot be distinguished from the latter by the possession of a true calcareous basi alone. The investigation has also revealed that a much more basic problem was incorrectly analyzed in the past. The mode of development of the so-called inflected wall and false basis of *C. hembeli* and the inflected wall of *C. intertextus* described by Darwin was misinterpreted by him. This misinterpretation has had unfortunate consequences in our understanding of both the systematic and the developmental morphology of these barnacles. It is hoped that the evidence presented here will elucidate the developmental sequences leading to the adult structural plan of these barnacles, and give us a clearer understanding of the relationships of these particular species.

Chthamalus intertextus Darwin

It is perhaps most appropriate to begin a brief description of the shell of these barnacles with a discussion of the wall of *Chthamalus intertextus,* for although the mature form of this species has a basal calcareous shelf which appears to be confluent with the wall, the remainder of the basis is membraneous rather than calcareous. The basal shelf, the serrate interlocking sutures, the calcification of the tergum to the scutum of each side, and the characteristic appendages make heavily eroded adults, of 10 mm or more in basal diameter, relatively easy to identify. However, smaller uneroded individuals, of 6 to 8 mm in basal diameter, were often found to lack the inner basal shelf and the tergum and scutum (fig. 1 A-D) on each side were not always calcified together. Such material lends itself to a study of the developmental sequence in the production of the basal shelf so pertinent to this discussion.

The method employed in studying the coarse structure of the wall of this barnacle is quite simple. The body and valves are removed, the parietal wall is broken into bilateral halves and the halves are mounted with medium Dekhotensky cement on a wooden peg. The peg is then hand held, the shell being ground by drawing it back and forth, first over a fine wet carborundum stone and then over a wet marble hone. The polished cross-section of the wall thus obtained can then be observed, either wetted with water or benzyl alcohol, under a dissecting microscope and drawn with the aid of camera lucida.

A comparison of figure 1 A with figure 1 C shows the difference between the juvenile and mature walls of *Chthamalus intertextus.* The calcareous deposit composing the shelf and the inner wall depicted in figure 1 C is a secondary production, differing conspicuously from the structural nature of the primary wall. Apparently the secondary wall does not immediately hinder growth by closure of the sutures of the primary wall; however, continued internal calcification seals the sutures, and this terminates the diametric growth pattern common to these barnacles. Growth along the basal margin beneath the shelf could conceivably continue as it does in certain species of *Tetraclita,* but this does not appear to be the case. The internal volume of the shell can only become less with continued secondary calcification; for now not only does a secondary wall grow inward but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secondary sheath is added to the old one from below, apparently in compensation or the erosion of the primary sheath from above (see fig. 1 C). Essentially the ame thing occurs in *C. hembeli,* as will be described below.

Curiously enough, each mature specimen removed from the limestone was ocated over a pit in the stone into which the body of the barnacle could be xtended. Whether or not the barnacle actually excavates the pit or has simply ettled in it only to later grow out over it, could not be determined. However the everal immature individuals removed from the limestone were not located over its. If it were not for the fact that this species has been reported on volcanic ock, the evidence would certainly suggest that it is excavation that takes place; or not only does the developmental sequence indicate that it does, but such a rocess would explain the lack of complete calcification of the basis and would olve the problem for the barnacle of reduced volume due to secondary calcification. It would be interesting to know if the individuals growing on volcanic ock are as peltate in form as those found on limestone, but such information s not available in the literature.

The important thing to note here is the nature of the inner basal calcareous helf. As seen in the adult individual, it indeed appears to be an inflected portion f the parietal wall. However, the ontogeny of the structure shows clearly that it s not an inflection of the wall at all, but rather a secondary production which epresents a maturational process and change in growth pattern in this species. ts advent obviously precludes growth of the primary wall. Such a determinant rowth system of the primary wall is certainly unusual among the cirripeds.

Chthamalus hembeli (Conrad)

Heretofore *C. hembeli* has been considered to have a false basis produced y an inflected portion of the parietal wall. This idea stems from Darwin who nvisioned a growth series beginning with a young stage without an inflected wall. It then passes through an inflected wall stage with a membraneous central ortion similar to the condition seen in mature *C. intertextus.* Finally the inflected wall forms a completely calcareous but false basis.

ig. 1. A-D, *Chthamalus intertextus.* A, ground cross-section of primary wall of juvenile; B, wall f same specimen as seen from below; C, ground cross-section of primary and secondary wall of ature individual (note development of secondary sheath, secondary wall, and shelf); D, same pecimen as seen from below. E-J, *Chthamalus hembeli.* E, ground cross-section of primary wall of uvenile; F, basal margin of same specimen as seen from below; G, margin of true basis of same pecimen as seen from above; H, lateral view of large specimen with ground V-notch cross-section ut through primary wall and true basis; I, ground V-notch cross-section of primary wall and true asis (note initial deposits of secondary material along the inner margin of the basal suture); J, round cross-section of wall, basis and secondary calcareous deposits of an old, much eroded individual (note heavy secondary inner lining which completely covers and fuses parietal wall elements nd fuses the wall to the true basis). K, L, *Chthamalus calcareobasis.* K, ground cross-section of wall and true basis; L, basal margin of wall of same specimen as seen from below. [Explanation of numbers: 1, primary wall; 2, secondary wall; 3, true basis. (A-G, K, and L, right scale; H-J, left scale)].

It is on the authority of Darwin that Henry claims *Chthamalus calcareoba* to be the only *Chthamalus* with a true calcareous basis. She apparently recogniz that something was wrong however, for she is the first to my knowledge notice that Pilsbry (1916) had seriously confused *C. intertextus* with *C. hemb* in his description of the hard parts of the latter species.

Figure 1 E depicts a cross-section of the wall of a juvenile of *Chthama hembeli* having a rostro-carinal diameter of 13 mm. This specimen was remov from the wall of one of the Hawaiian specimens, having a rostro-carinal diamet of 54 mm. Its shell was ground by the method employed on *C. intertextus* a it can be seen in the figure that there is no calcification on the interior of t wall and that the wall is not inflected. The basal margin, rather than bei inflected, has well developed basally directed teeth comparable to those seen *C. calcareobasis* (cf. fig. 1 F and L). The impression of these teeth can be se in the calcareous basis (fig. 1 G) after the wall has been removed.

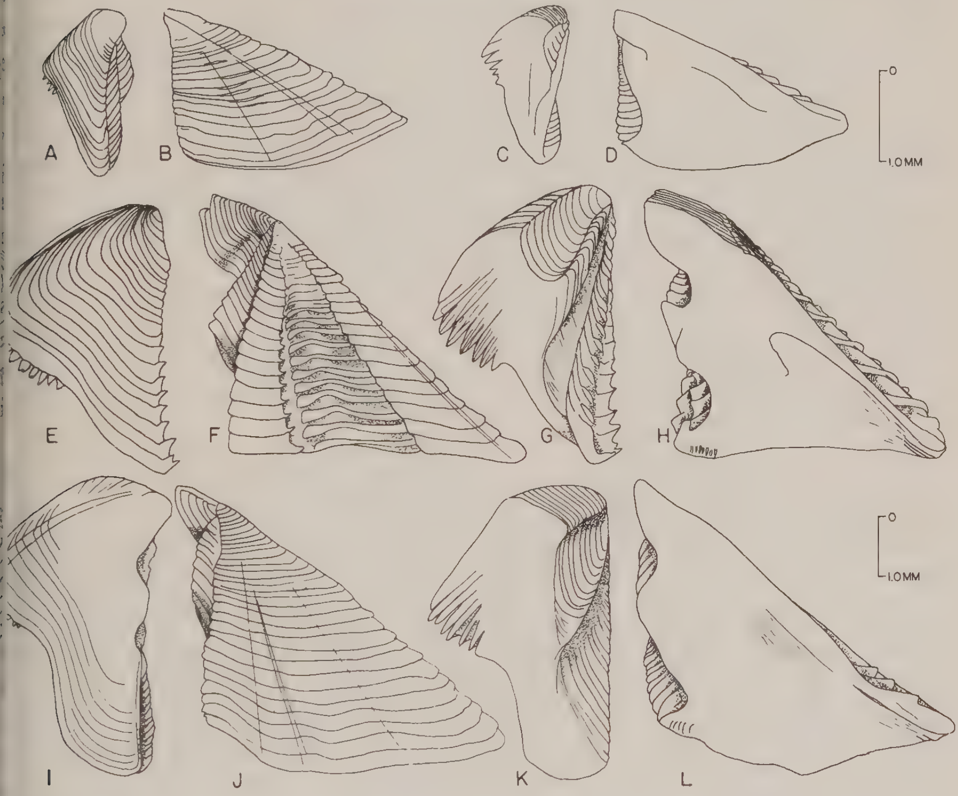
Unfortunately no trace remained of the body and appendages of this specim for comparison with those of *C. calcareobasis* to which it is comparable in siz However, the opercular parts were intact (fig. 2 E-H). Interestingly enough, th were not cemented together as are those of mature individuals, and the uncement condition is comparable to that described for *C. calcareobasis.*

The second specimen in the series, despite its large size (62 mm in rostro-carin diameter) has not undergone any marked secondary calcification. Figure 1 depicts a portion of this barnacle, with a V-shaped notch cut perpendicular to t basal suture with a triangular file, and then polished with a marble hone. Th lines coursing obliquely across the section of the wall appear to be due to grow increments, for near the less eroded basal margin which represents a younger are they match the growth lines visible on the outside of the wall. The true basis see in this specimen is still distinct from the primary wall. However, small continuou bridges now connect the wall with the basis and can be seen most clearly by viewin the specimen from within. Pores between these bridges extend between the bas margin of the wall and the basis. These represent the spaces between the basa teeth of the parietal wall described in the smaller specimen above. The sutures o the wall of this specimen are still distinctly open.

The next specimen in the series is 54 mm in rostro-carinal diameter. Viewe from within, the calcareous bridges have filled in, and hardly a trace of the bas pores can be found. It is indeed beginning to appear superficially that the basis completely confluent with the parietes and is actually part of them. However, notch ground perpendicular to the basal suture (fig. 1 I) shows the same situatio described for the earlier stage above, except for the small amount of secondary calcification along the interior of the basal suture.

The final stage in the series is seen in the form of the specimen of *Chthamalu hembeli* identified by Henry (1957) (U.S.N.M. Cat. #99340). As Henry has pointed out, the exterior of this animal is badly eroded. Viewed from within, hardly a vestige of the sutures can be seen, the original sheath is entirely eroded;

way, being replaced from below by a secondary sheath, and there is no trace of e inner basal pores. It must have been a form such as this, considered along with e comparative situation seen in *C. intertextus*, that lead Darwin to speculate on e mode of development of such a condition. A ground cross-section of the shell fig. 1 J) shows, however, the same basic pattern as seen in previous specimens, nly the amount of erosion and degree of secondary calcification differ. There is ill a true basis extending under the margin of the primary wall, and the oblique ansverse growth lines in the primary wall can be seen as well. Superimposed on is, on the internal surfaces, are thick concentric layers of secondary calcification



g. 2. A-D, opercular valves from a juvenile of *Chthamalus intertextus* (7 mm in rostro-carinal ameter). A and B, external view of tergum and scutum; C and D, internal view of tergum and utum (valves of mature specimens of this species are calcified together and cannot be separated, wever, juvenile valves are only cemented together and can be separated by soaking in 5% sodium pochlorite). E-H, opercular valves from a juvenile of *Chthamalus hembeli* (13 mm in rostro-carinal ameter). E and F, external view of tergum and scutum; G and H, internal view of tergum and utum (valves of mature specimen of this species are cemented together and can be separated by aking in sodium hypochlorite, however, juvenile valves are freely articulated and readily come art). I-L, opercular valves from a mature specimen of *Chthamalus calcareobasis* (approximately 5 mm in rostro-carinal diameter); I and J, external view of tergum and scutum; K and L, ternal view of tergum and scutum (certain mature specimens of this species examined had their valves cemented together in the same manner as seen in *C. hembeli*). E-L to same scale.

extending, from the secondary sheath, down the primary wall and out over the t basis. The whole animal is reduced from the high conic condition to a squ almost peltate form. This can be readily ascertained by extrapolation along t angles formed by the remains of the primary wall of the specimen, reconstructi the original form.

Comments made earlier on *Chthamalus intertextus* in regard to the effect secondary calcification on diametric growth and the interior volume of the she seem equally to apply to this species. However, *C. hembeli*, with its steep wall a remarkably large size, would appear to produce a much more commodious shell which to house itself than does the exceedingly peltate *C. intertextus*. It wou appear that the large size, at least in part, is an adaptation for the consequences reduction in volume by secondary calcification and by erosion. In any event, seems quite clear that secondary calcification in both *C. intertextus* and *C. hemb* is an adaptation to overcome the effects of erosion. As will be described belo *C. calcareobasis* is not known to reinforce its wall by secondary calcification. Coi cidental with this is the fact that *C. calcareobasis*, in contrast to most other speci of *Chthamalus*, has a very hard wall (a hardness greater than five on Moh's scal which is uneroded in the numerous specimens on hand.

Chthamalus calcareobasis Henry

The nature of the shell of *C. calcareobasis* is described and figured by Hen (1957) and nothing can be added here in regard to its structure. A figure of t ground cross-section of the wall and basis, and a figure of the basal margin of t wall of one of the paratypes (U.S.N.M. Cat. #96485, fragments #1903) a given here (fig. 1 K, L). This specimen is comparable in size to the immatu specimen of *C. hembeli* described above (cf. fig. 1 E) and like it, no seconda calcification could be ascertained. It would appear on the basis of the material o hand that this species maintains its diametric growth pattern throughout life.

Among the paratypes of *Chthamalus calcareobasis* examined, a few differenc from the original description were noted which bring it closer in structure t *C. hembeli* than was heretofore supposed. First, the terga and scuta (fig. 2 I-L of large *C. calcareobasis* are cemented together in the same manner as those o mature *C. hembeli*. This is a function of the broad articular surfaces which preve movement of one valve on the other. Ankylosis of the tergum with the scutum seen in a number of tropical reef barnacles (e.g. *Creusia* and *Pyrgoma* as well *Chthamalus*). There is the suggestion that this is an adaptation to the reef enviro ment where barnacles often become overgrown by calcareous algae and coral which tend to fuse their articulations.

The other differences are in the second maxilla and the setation of the sixt cirrus. The second maxilla is described and figured by Henry as having a notc which is reported to be lacking in the second maxilla of *Chthamalus hembeli*. Th right second maxilla of the paratype is absolutely without a notch while the lef one may have the barest suggestion of one, as indicated by a slight divergence in two spines and a slight discoloration in the chitin between them. It is unfortunate that variability in a structure such as this should turn up, for the presence or absence of a notch is usually considered a reliable character. Henry also points out that *C. calcareobasis* differs from *C. hembeli* in having three rather than four pairs of setae on the articles of the six cirrus. The paratype certainly has but three pairs of setae on segments 16 to 20 of the sixth cirrus, however, segments 1 to 15 have four pairs as does *C. hembeli.*

I would like to re-emphasize that *Chthamalus calcareobasis* is clearly distinct from *C. hembeli.* The bone white rather than pinkish or grayish-purple ground color, especially as viewed from without. The high rounded rather than high conic form, and the remarkably broad rather than acute tergal spur, are exellent diagnostic features when taken together.

CONCLUSIONS

I. *Chthamalus intertextus* Darwin

a. The internal basal shelf of *C. intertextus* is not an inflected parietal wall in the sense described by Darwin, but is rather the production of secondary calcification. The advent of secondary calcification terminates diametric growth of the primary wall.

b. The secondary sheath, secondary wall, and shelf are best developed in eroded (older) individuals. The development of these structures, in compensation for erosion, results in reduction of the internal volume of the shell.

c. It is suggested that the central portion of the basis, which remains membraneous in this species, does so to enable the body of the animal to extend down into a pit in the limestone substrate beneath it.

II. *Chthamalus hembeli* (Conrad)

a. The concept of the false basis and its development from the inflected parietal wall, as described by Darwin, is incorrect, for *C. hembeli* has a true basis in all the ontogenetic stages examined by me. The so-called false basis is not an inflection of the primary wall at all, but rather the result of secondary calcification involving the entire interior of the shell.

b. The secondary sheath, secondary wall, and secondary basis are best developed in eroded (older) individuals. The development of these structures in compensation for erosion, results in a reduction of the internal volume of the shell, and their advent precludes further diametric growth.

c. It is suggested that the shell in this large barnacle grows initially more commodious than necessary, "anticipating" reduced volume in later life.

III. *Chthamalus calcareobasis* Henry

a. This species is clearly distinct from *C. hembeli* despite the increased num ber of similarities between the two found here. The diagnosis of *C. calcareobas* must be emended, for what are apparently mature stages of *C. calcareobasis* a inseparable from juveniles of *C. hembeli* of comparable size by the existence o a true calcareous basis alone.

b. Additional emendations to the original description that should be made a described. Recognition of these characters narrows the systematic degree of di ference between these two species and undoubtedly they are very closely relate

c. Secondary calcification has not been observed in *C. calcareobasis* and dia metric growth assumedly progresses throughout life. The wall is particularly har and the specimens on hand are essentially uneroded. In that secondary calcif cation in both the afore-mentioned species appears along with severe erosion, is suggested that *C. calcareobasis* is specially adapted in having a shell particularl resistant to erosion, and is thus able to forgo secondary calcification.

I would like to extend my thanks to Dr. Cadet Hand for his reading an criticism of the manuscript of this paper.

RÉSUMÉ

La nature de la base chez trois espèces de la section *hembeli* du genre *Chthamalus* a été examin et décrite.

Le bord inférieur infléchi des parois du *Chthamalus intertextus* Darwin n'est pas une inflecti de la paroi primaire dans le sens décrit par Darwin, 1854. Ce bord est plutôt produit par u calcification secondaire, qui termine l'accroissement diamétral ultérieur du mur primaire.

Le concept de la fausse base et de son développement à partir de la paroi infléchie chez *Chth malus hembeli* (Conrad), décrit par Darwin, 1854, est incorrect, car ce Cirripède a une véritab base calcaire dans tous les stades ontogénétiques que j'ai examiné. Une calcification secondaire lieu chez les spécimens mûrs, et, quand cette calcification est bien développée, elle exclut l'accroi sement diamétral ultérieur du mur primaire.

La diagnose du *Chthamalus calcareobasis* Henry, 1957, doit être corrigée, car les stades mû de cette espèce ne peuvent être séparés des stades juvéniles de *C. hembeli* de taille comparable pa l'existence d'une vraie base calcaire seulement. On ignore si une calcification secondaire a lieu ch *C. calcareobasis,* et l'on présume que la croissance diamétrale progresse pendant toute la vie.

La signification de la calcification secondaire et le mode déterminant de crossaince imposé pa celle-ci ne sont pas connus. L'auteur suggère plusieurs possibilités, toutes en rapport avec les ada tations à la sévère érosion du mur primaire.

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NOTES ON SOME ASCIDICOLOUS COPEPODS FROM BRITISH AND IRISH WATERS

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INTRODUCTION

With a single exception, the copepods dealt with in this paper were collected n August, 1960, during a brief visit to Sheephaven — an Atlantic bay on the xtreme north-west coast of Ireland. Most of our information regarding Irish scidicoles has resulted from work carried out in Strangford Lough, a sheltered nlet on the County Down shore, well within the confines of the Irish Sea, and eparated from Sheephaven by over 300 miles of heavily-indented coastline (Got-o, various papers). The exception mentioned above is a copepod obtained from ne Plymouth area. Of the forms reviewed here, some are new to the British sles, while others are of interest mainly from the standpoint of host-specificity nd geographic distribution. After listing the species found and commenting riefly on each, it may be of interest to give a short summary on ecological nes of the Sheephaven area in so far as it seems to affect the ascidicolous opepods.

LIST OF SPECIES

Mycophilus roseus Hesse

One immature female, 0.66 mm in length, from a colony of *Botryllus schlosseri* Pallas) at low tide mark, Sheephaven. Although known from Strangford Lough, is is the first time that the species has been recorded from western Ireland.

Enteropsis sphinx (Aurivillius, emended Chatton and Brément)

Numerous females, ranging from immature and non-ovigerous specimens etween 0.9 and 3.2 mm, to ovigerous individuals measuring 2.0-2.7 mm, ob-ained from East Bay, Plymouth, in a colony of *Diazona violacea* Savigny. The atter was procured for me through the kindness of Mr. R. Tozer and Mr. Hugh Wallace.

When I first examined these copepods it was under the assumption that they ould prove to be *Enteropsis pilosus* — a species described by Canu in 1886, on the basis of a single female found in a *Diazona* colony from the Finistè coast (Brittany, France). Closer inspection, however, showed them to be almo exactly identical with the description of *E. sphinx* Aurivillius (1885) as emend by Chatton and Brément (1909) and re-studied by Chatton and Harant (1922 The French authors have done much to resolve the ambiguities surroundin Aurivillius' original description (based on specimens from the "Vega" expe tion) by pointing out that in all probability the Swedish writer was in fact dealin with two distinct species — *E. teres,* measuring about 8 mm, and *E. sphinx,* approximately 2-3 mm length. The host recorded by Aurivillius was *Caesi* (= *Molgula*) *ampulloides* (Van Beneden), whilst the specimen obtained Chatton and Harant came from *Tethyum* (= *Cynthia*) *papillosum* (Verrill) Port Vendres, S. France.

Now since the Plymouth specimens from *Diazona* correspond so precisely wi the emended description of *E. sphinx,* doubt must inevitably be cast on the validi of Canu's *E. pilosus.* His figures and account (which he admits to be "ve imperfect") of the single individual at his disposal, differ from his comp triots' later illustrations in the sort of small details which are discernible on with difficulty — though these same features, if accurately interpreted, wou certainly secure the specific identity of his copepod. I find it hard to believe th the examples from Plymouth are not conspecific with that seen by Canu in t same host, in which case *E. pilosus* should be regarded as a synonym of *E. sphin* However, since Canu was a most careful observer, it may be wiser to await fuller investigation of this genus on the western coast of Europe, before allowi *E. pilosus* to fall into desuetude.

So far, all of the young and non-ovigerous stages of *E. sphinx* have been fou in the stomach of the host. By contrast, adult females and egg-strings occur the pharynx. This is not as trifling a distinction as it might seem, since in *Diazo* the oesophagus is relatively very long and slender, reaching, in fact, a leng of some 20 mm. It appears, therefore, that the adult female *Enteropsis* carri out a migratory movement between stomach and pharynx in connection with th reproductive process. Probably this migration takes place prior to the actual e trusion of the egg-strings, since the towing of such unwieldy objects (up 3.6 mm in length) through the long, narrow oesophageal channel might w present difficulties. Three suggestions come to mind as regards the possible reaso for this laborious upward movement — and it may be that all are releva Firstly, the release of nauplii would be rendered easier by the proximity of th oral siphon, which would thus function as an escape hatch. Secondly, develo ment of the extruded egg-strings might be dependent on (or at least facilitate by) the higher oxygen content of the pharyngeal region. Finally, the hatchin process itself may be triggered by the inhalant current, just as the host's exhala stream appears to effect the final rupture of the egg membrane in the case another copepod commensal, *Ascidicola rosea* Thorell (cf. Gotto, 1957). It hoped to study these questions in more detail at a later date.

Enterocola sydnii Chatton and Harant

One non-ovigerous female from a small, stunted and somewhat atypical colony of *Morchellium argus* (Milne Edwards), low tide mark, Sheephaven. This is only the second specimen to be recorded in nearly 40 years, Chatton and Harant having described the species on the basis of a single individual found in *Sidnyum turbinatum* Savigny on the Brittany coast in 1922. Although the Sheephaven example differs in one or two minor respects, its identity seems reasonably certain. I am able to add the following notes on colouration to the original description: Head a semi-transparent yellowish-green, eye red, metasome pale violet (due to the contained ovaries), urosome pale reddish. Length 1.57 mm. Like other members of this genus, its movements are very sluggish.

Botryllophilus ruber Hesse

Four females, one ovigerous, from the pharynx of *Clavelina lepadiformis* (Müller), found at low tide mark, Sheephaven. This is a new host for *B. ruber,* and a new record for the west of Ireland. The copepods were a dull greenish shade, with the intestine showing as a red streak. The curious taxonomic situation within this genus has been discussed in some detail by Lang (1948).

Doroixys uncinata Kerschner

Two adult females from a colony of *Morchellium argus* found at low tide, Sheephaven. The only other locality in the British Isles from which this species has been reported is Strangford Lough.

Pachypygus gibber (Thorell)

One female from the pharynx of *Ascidia conchilega* Müller and 21 females from the pharynx of *Clavelina lepadiformis* — both hosts from low tide mark, Sheephaven. The specimen from *A. conchilega* was appreciably larger than any found in *Clavelina*, although many of the latter were fully mature, with eggs ready to hatch in the brood pouch. These bulky copepods were almost absurdly conspicuous in the branchial sacs of their small transparent hosts and seemed, for the most part, to favour the base of the pharyngeal region. The single individual found in *A. conchilega* must have occupied fully half the space available in the branchial sac, since the host was very small. This is the first occasion on which *P. gibber* has been reported from western Ireland, although it has been found on the north-east coast in *Corella parallelogramma* (Müller) (cf. Gotto, 1955).

Doropygus pulex Thorell

Two adult females of this widely distributed form were taken in the pharynx of *Ascidiella scabra* (Müller) at low tide mark, Sheephaven.

Notodelphys rufescens Thorell

One mature female was found in the branchial sac of a small *Ascidiella scabr* which also contained one of the *Doropygus pulex* mentioned above. Althou this is the first occasion on which *N. rufescens* has been recorded in British Irish waters, it has almost certainly been confused in the past with *N. allma* Thorell and perhaps with *N. caerulea* Thorell as well. Bocquet and Stock (196 have done a considerable service in re-emphasizing the great difficulty of sep rating individuals within what they describe as the "*allmani-rufescens* complex and it is on their criteria that the Sheephaven specimen has been assigned to *rufescens.* Further research on this genus is likely to reveal that the taxonom picture is even more intricate than we at present suppose.

Notodelphys elegans Thorell

Five mature females and one immature female from the pharynx of *Cion intestinalis* (L.), low tide, Sheephaven. The only localities in British or Iri waters from which this copepod has been previously reported are Southampt and Jersey.

Notodelphys transatlantica Bocquet & Stock

Three mature females from the pharynx of *Clavelina lepadiformis,* low ti Sheephaven.

This species has been described very recently by Bocquet and Stock (1960 who obtained their specimens from the same host at Roscoff, Brittany, Franc The Irish examples appear to possess an 11-segmented antennule as against t 12 segments of the Roscoff forms. However, as Bocquet and Stock have alrea remarked, the articulation of this appendage is indistinct. A further small di ference lies in the rather greater degree of ciliation on the caudal rami of th Irish specimens. Most of the outer margin carries these fine hair-like processe although only the distal third of the inner margin is similarly ornamented.

As Bocquet and Stock have pointed out, their species belongs to a small b well-defined group which, up to the discovery at Roscoff, was exclusively ass ciated with the New World — Washington and California on the Pacific coa North Carolina and the Antilles on the Atlantic side. Its occurrence in Doneg Ireland, extends the known European range by some 500 miles to the north-we and was to be expected if indeed it is a copepod primarily distributed along the coasts which are washed by the temperate North Atlantic. I believe that th may prove to be the case for the following reasons: 1. *N. transatlantica* is quit sharply characterised, and could scarcely be taken for any of the eight remainin European species. It is therefore unlikely to have been found but misidentifie 2. The host ascidian, *C. lepadiformis*, is, according to Berrill (1950), "a beautif and conspicuous species found throughout European waters". It is, furthermore, " very shallow water species, commonest just below low tide level, though som times occurring in water of 50 metres". We are not, therefore, dealing with a host species which is either rare or inaccessible to ordinary methods of collection. 3. *Clavelina* must afford less privacy to a copepod associate than almost any other host. Its glass-like tunic exposes to view any commensals present, even with the naked eye, and even when they are considerably smaller than a notodelphyid. Detection of this species should thus have been an easy matter.

In spite of these considerations, *N. transatlantica* has eluded description until last year. It seems likely, therefore, that it is simply not present along a considerable stretch of the well-worked coastline of western Europe and its associated islands, e.g., the English Channel, North Sea and Irish Sea — all places where its host is available. Perhaps it might be found in western Scotland, but its seeming absence from Norway, where so much work was done in this field by Sars, may possibly be linked with uncongenial sea-temperatures. All this, of course, is highly speculative, but even its disproof will add to our scanty knowledge of ascidicole distribution.

SHEEPHAVEN AS A LOCALITY FOR ASCIDICOLOUS COPEPODS

Certain aspects of this area may be worthy of note in that they reveal some interesting facets of ascidicole ecology — although it should be remembered that the time available for investigation was very short.

Sheephaven Bay is a broad but sheltered inlet with a north-westward entrance to the Atlantic. The collecting area was the southern aspect of a slightly projecting rock reef on the western side of the bay and well within its entrance. A hundred yards south of this reef is a wide beach of fine sand (Marblehill Strand), extending for more than a mile. To the north, small cliffs alternate with sandy bays. Only in the collecting area (about 30 yards long by 7 yards wide) are movable stones and boulders found, associated with a variety of seaweeds. Adjacent areas offer only exposed rock faces or sandy expanses to intertidal colonisation by ascidians.

The stones of the chosen reef (which is fully uncovered only at low spring tides) are largely coated by a fairly firmly compacted layer of sand, in which grows a small green alga — probably a species of *Cladophora.* Other seaweeds on the reef include *Fucus serratus* L., *Chorda filum* Stackh. and *Laminaria.* The most obvious intertidal animals during August were numerous young galatheids, *Cancer pagurus* L., *Pomatoceros triqueter* (L.) and nereid worms.

By comparison with the rich tunicate fauna of Strangford Lough, the ascidians present a curiously depleted picture. Around the edges of the partially-embedded stones flourishing groups of *Clavelina lepadiformis* are fairly abundant. Of larger single forms, *Ciona intestinalis, Ascidia conchilega* and *Ascidiella scabra* are all present, though never numerous and represented almost wholly by rather small individuals. Very few colonies of *Morchellium argus* were seen, and these likewise appeared to be stunted. *Botryllus schlosseri* occurred only sparsely as small yellow colonies, and no didemnids were noticed. This virtually completed the tally. Altogether one was left with the impression that, of the few ascidians present, C. *lepadiformis* was the only one to have secured a strong foothold in this particular area. Although its individual zooids are small, the combined "pharyngeal Lebensraum" which they provided was probably greater than that of all the other ascidians put together.

Now it will be apparent from the list of copepods found here that *Clavelina* is a popular and indeed somewhat overloaded host. Apart from *Notodelphys transatlantica,* which has already been discussed, it shelters *Botryllophilus ruber* — never previously recorded from this ascidian — and especially *Pachypygus gibber*. The percentage of zooids infected by the latter is, in fact, remarkably high. This state of affairs is mildly astonishing to anyone familiar with the ascidicoles of Strangford, where, amid a far richer assemblage of tunicates, *C. lepadiformis,* although quite abundant, is almost completely free from copepod commensals and parasites. It would seem, therefore, that the adverse conditions which inhibit intertidal colonisation and development for so many ascidians at Sheephaven have also presented their copepod partners with acute problems as regards the suitability and selection of such hosts as are available. That these housing difficulties have been largely overcome is indicated by the diversity and abundance of the ascidicole population — even though some of the latter are inhabiting sea-squirts which, in other areas, are either ignored as hosts, or at least would occupy lowly positions in a preference list. These observations would seem to stress the great adaptability of several ascidicolous forms, and to some extent cut across well-worn concepts of host-specificity. That such adaptations are not always achieved without visible effect is perhaps shown by the case of *Pachypygus* in *Clavelina,* for although the copepod attains full sexual maturity, it remains far smaller than individuals which inhabit hosts of the family Ascidiidae.

It could, of course, equally be argued that integration with atypical hosts must inevitably involve subtle refinements of physiological adjustment, so that such populations would in reality represent distinct biological races. More data must be obtained before deciding which explanation is correct.

SOMMAIRE

La présence de neuf espèces de Copépodes ascidicoles dans la Baie de Sheephaven (nord-ouest de l'Irlande) et d'une espèce à Plymouth est notée. Plusieurs d'entre elles sont nouvelles pour les Iles Britanniques, et plusieurs ont été trouvées dans des hôtes nouveaux. Des observations sur l'écologie de la baie de Sheephaven sont également notées, dans la mesure où cette écologie semble affecter les Copépodes ascidicoles.

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NOTES AND NEWS

PROBABLE LARVAE OF *PASIPHAEA MULTIDENTATA* ESMARK

BY

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In my recent paper on pasiphaeid larvae (Williamson, 1960) I overlook the work of Sivertsen & Holthuis (1956), who showed *Pasiphaea princip* Sund to be a synonym of *P. tarda* (Krøyer) and also gave a more extenc range than had previously been recognised to *P. multidentata* Esmark. In light of this information, the larvae from north Biscay which I attributed *P. principalis* (cf. Williamson, 1960: 337, fig. 2 g-i) now seem likely to bel to *P. multidentata.* My suggestion that the larvae were probably too large *P. multidentata* was made on the assumption that there is a fairly direct relati ship between larval size and adult size in the species of *Pasiphaea,* but suc relationship is not universal in other caridean genera, and therefore size al cannot be regarded as sufficient reason for excluding the larvae from *P. mu dentata.*

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THE OCCURRENCE OF *UCIDES CORDATUS* (LINNAEUS, 1763) (DECAPODA) IN THE UNITED STATES

BY

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Ucides cordatus (L.), a large land crab known from the Caribbean and northern coast of South America (Rathbun, 1917; Holthuis, 1959), has not be reported from the United States mainland. We recently have had the opportun to collect and examine several mature specimens from Biscayne Bay, Mian Florida.

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[1] Contribution No. 302 from The Marine Laboratory, University of Miami, Miami 49, Flori

This species was first collected in Florida on 28 April 1954 when a single ale specimen was found on the premises of The Marine Laboratory at Virginia ey, Miami, by Craig Philipps.

The species was not again taken in Florida until L. B. Holthuis and the writers ound a male and four females (one dead) in southern Biscayne Bay, Dade ounty, Florida, on the night of 15 September 1960. The five specimens were llected at low tide in about six inches of water on a soft, muddy bank partly vered with scattered patches of manatee grass, *Cymodocea manatorum* Ascher- n. The shore was lined with the red mangrove, *Rhizophora mangle* L., and a w filled road extended about 70 yards into the water from the shore. All f the specimens were found in the water, and none was observed on the exposed arl flats under the mangroves. The area is heavily populated by *Cardisoma anhumi* Latreille, the large white land crab.

During the week of 19 September 1960 two additional large males were ken at the same locality in daylight by F. M. Bayer of the U. S. National useum, and numerous other specimens were observed, all of them in the water.

The male specimens have carapace breadths of 62.5 and 83.5 mm, and the arapace breadths of the females range from 56.1 to 68.4 mm. Although the elipeds are normally unequal, those of one female are subequal, both being e size of the major cheliped of the other females.

The specimen from Virginia Key and one female from lower Biscayne Bay ave been deposited in the Museum of The Marine Laboratory. One female and vo males from lower Biscayne Bay are deposited in the U. S. National Museum, d the remainder of the material is deposited in the Rijksmuseum van Natuur- ijke Historie, Leiden.

Although this crab has not previously been collected from Florida, it is inter- sting to note that the well-known Florida naturalist, Charles Torrey Simpson, ecorded *U. cordatus* in 1932 from shores of upper Biscayne Bay (p. 120). Simpson oted that it had not been recorded north of Cuba. Evidently his record has gone nnoticed until this time. Apparently the species has been established in Florida or some time.

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NOTICE SUR PIERRE ALFRED CHAPPUIS ET SON ŒUVRE SCIENTIFIQUE

PAR

CLAUDE DELAMARE DEBOUTTEVILLE et R. ROUCH

La mort de Monsieur Pierre Alfred Chappuis survenue à Berne le 9 Juil 1960, laisse un grand vide dans le monde carcinologique. Pierre Alfred Chappu était né le 5 Septembre 1891 à Saint Cloud dans le pavillon de Breteuil, son pè étant Directeur-Adjoint du bureau international des Poids et Mesures. A vr dire, cette naissance en France, au sein d'une famille suisse de haute traditi allait orienter toute la vie de ce chercheur qui a fait ses études et a travaillé lon temps en Suisse mais a collaboré constamment à des entreprises où la Fran jouait un rôle important. On peut dire que son cœur et sa curiosité d'espr l'orientaient également vers tous les peuples et toutes les cultures; de telle sor que si son œuvre scientifique est relativement spécialisée, et c'est à ce titre qu'el nous intéresse ici, l'homme était imprégné de cet humanisme international q fait le charme d'un certain nombre de ses contemporains. C'est à ce titre que to les scientifiques intéressés aux Crustacés, ressentiront plus cruellement sa d parition. Nous croyons qu'il n'est pas inutile de fournir ici un certain nombre renseignements permettant de bien situer une carrière qui s'est ainsi développ dans le cadre d'une vaste coopération internationale.

ANALYSE DE L'ŒUVRE SCIENTIFIQUE

Il est impossible de donner une analyse complète des quelques 160 trava publiés par Chappuis. L'ensemble de son œuvre est consacré à l'étude du domai souterrain et particulièrement à la systématique des crustacés des eaux souterrain Ces travaux ont été poursuivis à Cluj, en Roumanie, au laboratoire Internation de Spéologie fondé par Racovitza avec la collaboration de Jeannel; Chappuis f Sous-Directeur à Cluj pendant plus de vingt ans. Quelques années après la gue re Chappuis venait s'établir définitivement en France où il était nommé Maît de Recherches au C.N.R.S., Sous-Directeur du Laboratoire Souterrain de Moul dans l'Ariège. Il venait d'être nommé Directeur de Recherches.

Syncarides. C'est la découverte des Bathynelles dans la région de Ber en 1914(1) qui devait être à l'origine de la spécialisation de Chappuis. Il rev à bien des reprises, au cours de sa carrière sur l'étude de ce groupe (15, 16, 20, 78, 82, 83, 132, 133, 134).

Nous lui devons l'essentiel de nos connaissances sur les espèces européen et la découverte du genre *Parabathynella.* L'extension des prospections dans d régions lointaines au cours de ces récentes années put faire, grâce à lui, des progr rapides.

Isopodes Asellides. Chappuis a considérablement élargi les connai sances sur la systématique et la répartition des espèces de ce groupe, continua ainsi d'une façon fertile l'œuvre de son maître Racovitza. Il fut à l'origine, au tôt après Karaman, de l'extension de nos connaissances sur l'intéressante famille es Microparasellides (68, 82, 98, 130, 133, 135, 136, 137, 138, 139, 142, 143, 44, 145). Nous lui devons en outre la description de plusieurs types génériques: *ygonectes* (70), *Stygasellus* et *Synasellus* (84), *Pseudasellus* (90), *Protocharon* 125); les descriptions de Chappuis, en ce qui concerne particulièrement les sellides souterrains, sont d'une grande précision, et les nombreux matériaux is par lui constitueront l'une des bases dans l'étude de la répartition et de la ous-spéciation dans ce groupe.

Copépodes Harpacticides. Les travaux sur les Harpacticides sou- rrains constituent l'essentiel de l'œuvre publiée. Il est impossible d'analyser i cet ensemble si polymorphe. Il suffira de se reporter à la magistrale mono- aphie récapitulative de Lang (1948) pour apprécier combien est important l'ap- ort de Chappuis dans la connaissance que nous avons de ce groupe.

Des matériaux de tous les coins du monde ont été régulièrement étudiés pen- ant plus de 40 ans. Des clefs de détermination aussi bien des genres que des spèces facilitant ainsi le travail des biologistes, ont été données.

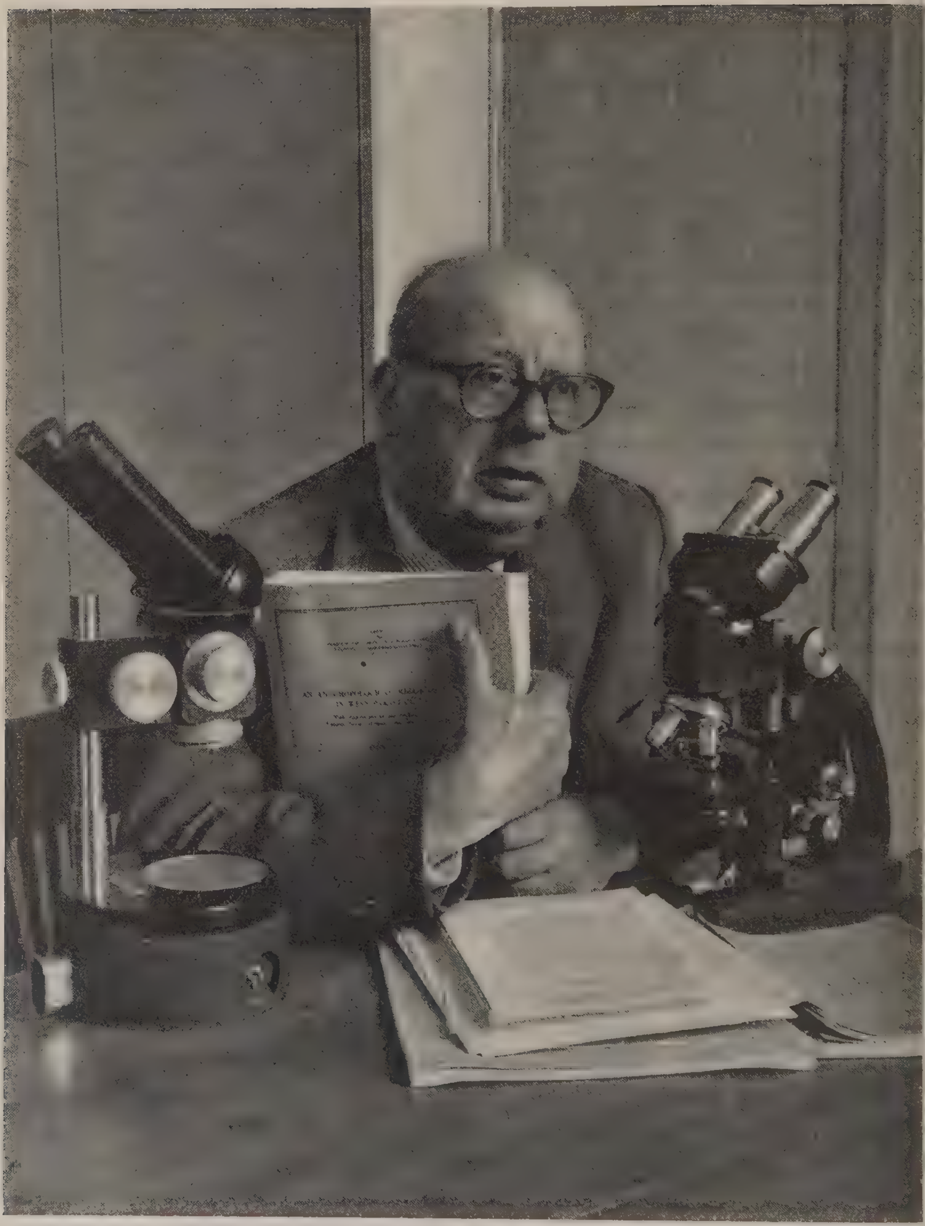
Mystacocarides. C'est Chappuis (146) qui a su trouver le premier, 'une façon certaine, le biotope d'élection des Mystacocarides permettant ainsi e confirmer ce que les captures de Remane, puis de Delamare, permettaient de ressentir. C'est en compagnie de Chappuis que nous eûmes l'occasion de définir etit à petit, sur le terrain, les modalités écologiques dictant la répartition de ces nimaux dans la nature.

Méthodes d'études du milieu souterrain et travaux 'ensemble.

Dès le début de sa carrière Chappuis avait l'occasion de brosser un tableau énéral de nos connaissances sur les eaux souterraines dans son classique volume aru comme tome 3 de la série „Die Binnengewässer" (19). Après de nombreu- es années d'expérience de ce milieu, il fut en 1942 (69, 77) à l'origine d'un enouvellement total dans cet ordre de recherches. C'est lui qui découvrit la mé- hode, maintenant classique, qui consiste à creuser des trous dans les alluvions es rivières pour recueillir, avec le filet à plancton, la faune attirée avec l'eau de rainage. A partir de ce moment, nous pouvions prospecter les eaux souterraines 'une façon intensive et systématique et non plus seulement par ces coups d'oeil ccidentels et sporadiques sur les eaux souterraines que sont les puits, les sources les grottes. Dans les différents pays d'Europe de nombreux chercheurs firent es recherches dans la voie ainsi ouverte par Chappuis (Motas, Szalay, Walter, ngelier, Karaman, Petkovsky, Şerban, etc....). Chappuis restait en correspon- ance avec tous et fut pour tous un excellent collègue. Son nom restera associé ans l'esprit de tous les carcinologistes à la voie qu'il a su ouvrir.

LE CHERCHEUR ET L'HOMME

Maintenant que nous avons analysé les grandes lignes de l'œuvre scientifique e P. A. Chappuis, peut-être pouvons-nous donner brièvement quelques renseig-



Pierre Alfred Chappuis 1891—1960

nements sur ce qu'il est convenu d'appeler le tempérament du chercheur. Nou sommes évidemment trop jeunes pour avoir personnellement des souvenirs su l'ensemble de cette carrière scientifique. Ce que nous pouvons dire sera en grand partie vu au-travers des souvenirs de ceux qui furent ses amis et particulièrement e ceux qui participèrent aux mêmes missions lointaines que lui. P. A. Chappuis pouvait paraître au premier abord froid et assez distant car il n'accordait son amitié qu'avec circonspection attachant à ce sentiment une haute signification. Ce qui aurait pu être interprété comme de la froideur tenait en réalité à une grande timidité et à une grande prudence tant il avait peur de heurter les hommes et de ne pas les comprendre bien. Cet homme était en réalité bon, serviable et d'une droiture à toute épreuve. Ses conseils étaient sages et son tempérament pondéré.

Contrastant avec ce tempérament calme, une vigueur physique exceptionnelle orientait naturellement Chappuis vers les activités de terrain et les missions périlleuses. Sa patience, là encore, était d'un grand secours en toutes circonstances. Le Docteur Jeannel nous disait l'avoir vu travailler pendant deux jours en plein désert, au cours de la mission de l'Omo, pour démonter le changement de vitesse de son camion et le remettre en marche alors que tout autre, à sa place, aurait renoncé. Ce sont certainement ces qualités morales et physiques qui ont fait de Chappuis, à côté d'un carcinologiste important ainsi que nous l'avons vu, un remarquable naturaliste de terrain. Il attachait d'ailleurs aux recherches sur le terrain et aux lointaines missions, une véritable valeur formatrice. Il était persuadé que le zoologiste qui reste en place se prive des meilleures possibilités et ne peut comprendre les problèmes qu'avec difficulté.

Mais ces qualités et ces goûts ne sont pas suffisants pour expliquer l'extraordinaire intuition de ce chercheur dans la nature. Chappuis possédait, au plus haut point, ce sens inné du biotope qui caractérise les meilleurs naturalistes. Il pouvait passer dans des régions parcourues par de nombreux collègues avant lui, et il s'arrêtait aux bons endroits; à ces endroits privilégiés où la conjonction de conditions difficiles à préciser objectivement, rendait probable une découverte exceptionnelle. Toute sa carrière a été ainsi orientée et fertilisée par ce don exceptionnel, qui surprenait au plus haut point tous ceux qui l'approchaient. Les premières découvertes des *Bathynella* en Suisse, celles des *Bidessus* en côte d'Ivoire, celle de la généralité du domaine souterrain, celle des formes remarquables vivant sous les plages, sont là pour attester d'une continuité de préoccupations certes, mais aussi d'un caractère heureux dans les investigations de terrain.

Une autre qualité maîtresse et surprenante chez Chappuis était son extraordinaire habileté aux dissections fines. Cet homme imposant, on pourrait dire impressionnant, avait des mouvements très précis. Lorsqu'il s'asseyait à la loupe binoculaire ou au microscope, il parvenait du premier coup à effectuer des opérations, dans les conditions où d'autres auraient essuyé plusieurs dizaines ou centaines d'échecs. Poussée à ce point, l'habileté manuelle représente beaucoup plus qu'un don inné; elle correspond à une éducation longuement parfaite et savamment entretenue.

Les apports de Monsieur Chappuis à la carcinologie souterraine sont très importants. Il suffira, pour s'en convaincre, de consulter la liste de ses travaux.

Nous serons heureux si ces quelques pages ont permis de montrer, bien imparfaitement, les qualités d'un chercheur qui laissera un souvenir très vivant dans l'esprit

de tous ceux qui ont eu le plaisir de l'approcher en tant que collègue, ou le bonh
de bénéficier de ses conseils.

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Reçu: 27 octobre 1960

REVIEW

Claude DELAMARE DEBOUTTEVILLE. — Biologie des eaux souterraines littorales et continent
1 vol. 740 p., 254 figs. dans le texte. Prix 60 N.F. Paris, Hermann, 115 Boulevard Sa
Germain, Paris 6e.

Le problème étudié dans cet ouvrage est celui de la jonction des continents à la mer du poin vue de la biologie souterraine. Dans cette zone frontière s'interpénètrent la faune interstitielle sédiments littoraux marins et celle des nappes continentales d'eau douce. Cette étude comporte l'analyse des conditions topographiques qui rendent possibles de tels mélanges, la granulométrie compacité, les mouvements des sables, la température, la salinité de l'eau interstitielle. Elle porte aussi une connaissance précise de la faune, dont maints types nouveaux ont été décrits, de fluctuations, de ses origines, des adaptations singulières des animaux qui la composent, tant su plan physiologique que morphologique. A signaler ici spécialement, outre la revue, abondamm illustrée, des Crustacés rencontrés dans ce milieu (chap. XII), les études monographiques Isopodes Microparasellidae et Microcerberinae (chap. XV) et du Mystacocaride *Derocheilo remanei* (chap. XVI et XVII). En conclusion de ce remarquable ouvrage, où apparaît la maîtris l'auteur dans ce domaine, on constate qu'il existe une unité foncière du monde souterrain: la plu des caractères morphologiques ou biologiques de la faune souterraine littorale sont les mêmes ceux de la faune des eaux souterraines continentales dont le peuplement s'est fait et continue d faire par cette voie.

L.

MOLTING FREQUENCY OF MATURE *GAMMARUS ZADDACHI*

A CORRECTION

BY

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)wing to a most regrettable accident, which took place after the proof readings
my paper "Growth, molting frequency, heart beat, number of eggs, and incu-
ion time in *Gammarus zaddachi* exposed to different environments", table II on
e 29 of this volume became meaningless.

his table should read as follows:

TABLE II

lting frequency of mature G. zaddachi *females at different temperatures and nities. Individual data. The left column gives the duration of the intervals veen two subsequent molts; the body of the table contains the corresponding reference temperatures in °C.*

rvals days	$5^{0}/_{00}$				$10^{0}/_{00}$				$30^{0}/_{00}$		
13	20.3	20.9	21.5	—	19.1	20.3	21.0	21.1	23.1	20.1	21.7
14	17.9	18.8	18.9	19.0	19.1	19.0	—	—	19.4	18.4	20.5
15	18.9	18.4	18.9	19.6	17.4	17.0	17.6	16.8	17.5	19.0	—
16	16.0	15.4	15.9	16.7	16.0	16.6	16.2	15.6	16.9	16.5	—
17	14.5	15.6	16.1	15.3	15.0	15.5	14.8	15.9	15.2	16.4	—
18	15.6	15.8	15.0	14.3	14.8	14.5	15.0	—	15.7	—	—
19	14.0	14.7	14.3	14.3	14.2	14.3	14.5	14.5	14.9	—	—
20	14.1	14.2	14.0	13.8	14.0	13.7	14.0	14.1	14.5	14.1	—
21	14.1	14.0	13.6	14.6	14.0	13.7	13.7	—	14.0	14.3	—
22	13.8	14.2	—	—	13.6	13.5	—	—	—	—	—

A RE-EXAMINATION OF THE SPIDER CRAB *EURYNOME* LEACH FROM BRITISH WATERS

BY

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INTRODUCTION

It has generally been supposed that there is only one species of *Eurynome* sent in the European and North African regions (Balss, 1929; Bouvier, 1940; nod, 1956), this being usually referred to as *E. aspera* (Pennant). A number other species have been described from this area, but these have all been sidered synonyms of *E. aspera.* The purpose of this paper is to show that in the rt Erin area two species are present, which may be readily separated by size, earance and ecological preferences.

I have collected in the Port Erin area a large number of specimens of both cies, each of which will be described in detail below. I have also examined material in the British Museum collection, and this has provided some infor- tion on the geographical distribution of each species.

SUMMARY OF LITERATURE

In order to discover what specific name, if any, is available for the second cies from Port Erin, a careful survey of the earlier literature was made. Here rief summary of the relevant papers is given: —

.. Pennant (1777: 8, pl. ixA fig. 20) first described a species of *Eurynome,* *Cancer asper.* The type specimen no longer exists, and his description is inade- te: "Crab with a cordated body; bifid snout; legs and claws short; those and body rough and spiny." However there is a figure which, while poor, is ficient to show which species he is describing. The specimen is "from the tland cabinet", so it is probably from Weymouth.

. Leach (1814: 431) created the genus *Eurynome,* and so the above species ame *Eurynome aspera* (Pennant).

. Risso (1827) described two supposed new species from the Mediterranean, ich he called *Eurynome scutellatus* (: 21, pl. 1 fig. 2) and *E. Aldrovandi* 22). The figure and description of the former are poor, but it is most probably nonym of *E. aspera* (Pennant); Bouvier (1940) considered it so. With referen- to *E. aldrovandi,* Risso refers to a figure in Aldrovandus (1606: 205) of

"Cancer macrochelos alius" which definitely shows *Lambrus angulifrons* Latre 1825. In the Bibliothèque Centrale, Muséum National d'Histoire Naturelle, P there are a number of unpublished manuscripts of Risso's including a plate show "*Lambrus Aldrovandi* n." (Ms. 2053, III (Zoologie), E. (Crustacés), 2 (Ic graphie), cahier 5, pl. 37). The figure is of *Lambrus macrochelos* (Herbst, 17 this identity being confirmed by Roux (1828 (1): expl. of pl. 1). In a footn to his explanation of pl. 1 showing "*Lambrus mediterraneus* nob." (= *L. ma chelos*), Roux stated: "M. Risso a bien voulu m'assurer que son *Eurynome Al vandi* était le même Crustacé que celui que je décris sous le nom de *Lam Mediterraneus*...".

Thus the original description of *E. aldrovandi* is based on two species, *L. an frons* and *L. macrochelos*. I designate as lectotype of *E. aldrovandi* Risso Ris own specimen of *L. macrochelos* of which a figure exists in the manuscr referred to above. Hereby *E. aldrovandi* Risso, 1827, becomes a junior subjec synonym of *Cancer macrochelos* Herbst, 1790.

4. Hailstone (1835: 549-550, fig. 47) described and figured a new specie *E. spinosa*. based on a female of 3 mm carapace length. This specimen differs only from adult individuals of *E. aspera*. but also from small examples abo mm long. Hailstone's illustration shows that he had before him a specime the other British species. As this appears to be the earliest name, since, as alr pointed out, neither of Risso's names seems appropriate, I propose to ca *E. spinosa* Hailstone.

5. Costa (1838: 8-10, pl. 3 fig. 3) described a new species, *E. boletifera,* f the Mediterranean. The description and figure resemble *E. aspera* closely, an is probably a geographical variant of this species. It has no resemblance t *spinosa*.

6. Malm (1861: 619) described a new species, *E. tenuicornis*, from Swe His short latin diagnosis may be translated thus: "Rostrum narrow, bifid, third total length of cephalothorax; rostral horns very long, graceful, curved diverging. Carapace regularly ornamented with small, slightly depressed wa but longer and spiniform on the edges, and also on the legs". This specie the same as *E. spinosa*, and its description is the first published account of adult of the species.

7. A. Milne Edwards and Bouvier (1900: 125-127, pl. 19 figs. 7-15) descr a variety of *E. aspera* from the African Atlantic region which they design var. *acuta*. This does not resemble *E. spinosa*. but is a geographical varian *E. aspera*.

8. Lagerberg (1908: 94, pl. 4 fig. 3) redescribed and figured *E. tenuico* as *E. aspera* var. *tenuicornis*. This is another synonym of *E. spinosa*.

Eurynome Leach, 1814

DIAGNOSIS OF GENUS: Carapace roughly triangular, ornamented with spines boletate tubercles; antero-lateral longer than postero-lateral border. Rostral ho ointed, separated by a V-shaped cleft. Dorsal wall of orbit formed by ledge-like upra-orbital lobe and post-orbital spine; between them is an intercalary spine, uch reduced in the adult. Four tubercles on antero-lateral border behind the ost-orbital spine; three median-dorsal groups of tubercles — gastric, cardiac and ntestinal [1]); epibranchial and mesobranchial spines prominent; other scattered ubercles. Hooked setae on inner edge of rostral horns and dorsal surface of arapace. Fused second and third segments of antennal peduncle as wide as long, arrowed and truncate anteriorly. Epistome triangular. Lower margin of the orbit ormed largely by the antennal peduncle and a small infra-orbital spine. Thoracic ernum of male with a deep groove for the abdomen; a series of tubercles on the hird sternite. Abdomen narrow, all seven segments free, ending in a blunt point; bdomen of female broader, covering the whole sternum in mature specimens.

Antennal flagellum reaching to about end of rostrum, with approximately venty segments. Cheliped of mature male much longer than the walking legs, nly slightly longer in the female; longitudinal rows of spines on merus, carpus nd propodus; fingers much shorter than palmar region, inflected, tips black. Walking legs becoming slightly shorter posteriorly; dorsally cristate on merus and arpus. First male pleopod with a slight S-bend; pointed distally, with a recurved ook and a number of small spines on the inner edge; about three times as long s the second pleopod.

Eurynome aspera (Pennant) (figs. 1, 2, 3a, 4a, b, 5a, 7)

77 — *Cancer asper* Pennant: 8, pl. IXa fig. 20.
14 — *Eurynome aspera* Leach: 431.
27 — *Eurynome scutellatus* Risso: 21, pl. 1 fig. 2 (*scutelatus* on: 21).
38 — *Eurynome boletifera* Costa: 8-10, pl. 3 fig. 3.
00 — *Eurynome aspera acuta* A. Milne Edwards and Bouvier: 125-127, pl. 19 figs. 7-15.

Pennant's type specimen no longer exists. The following specimens of the Port rin material were deposited in the British Museum (Nat. Hist.) as characteristic amples of the species: one male, Reg. No. 1960.8.30.6; one male, Reg. No. 960.8.30.4 (illustrated in fig. 6); one female, Reg. No. 1960.8.30.5.

DESCRIPTION OF MALE (figs. 1, 2). A full description of the first listed specimen Reg. No. 1960.8.30.6), a normal mature male collected in the Port Erin area, first given.

Carapace roughly triangular, the straight antero-lateral slightly longer than the mewhat convex postero-lateral border. The surface with many spines and tuber- es, the important ones being constant in number and position.

The rostral horns are short and broad across the base, with a V-shaped gap etween them. Width across the base of the rostrum greater than the length from e tip to the junction with the orbit. The dorsal wall of the orbit is formed by a ide supra-orbital lobe separated by a narrow hiatus from the post-orbital spine. t the base of this hiatus is the reduced intercalary spine (fig. 2, *is.*).

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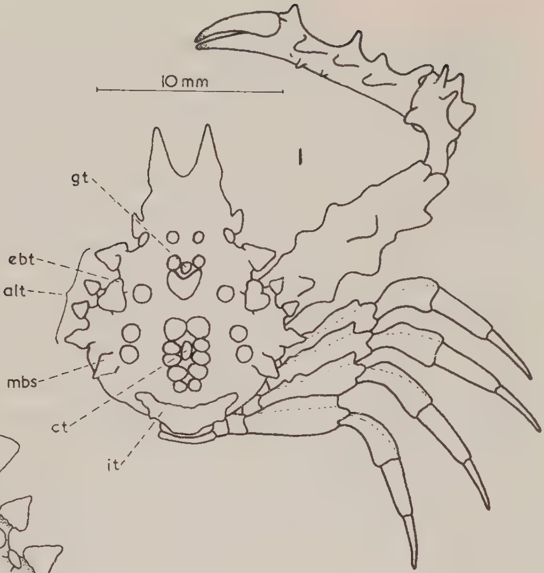
[1]) The terms used for describing the areas of the carapace are those given by Rathbun (1925); e position of the important tubercles is shown in fig. 1.

The dorsal surface of the carapace has the following principal ornamentatio situated behind the post-orbital spine along the antero-lateral border are a larg scutellate tubercle, two smaller boletate ones, and a conical rugose spine. In th midline there are three groups. An anterior gastric group comprises a media bluntly conical tubercle with behind it a U-shaped group of fused tubercles, front of which is a pair of boletate tubercles, one opposite each arm. Posteri to this is a very conspicuous cardiac group, consisting of a blunt granular prom nence with a crescent of five partly fused boletate tubercles on each side. Near th posterior edge of the carapace is a large crescentic transverse group which I sha refer to as the intestinal group (it contains elements from both intestinal an metabranchial areas). The crescent consists of a median group of three fuse disc-like tubercles, on each side of which are about five fused tubercles and a blu spine. Each branchial area has two main protuberances. The anterior one is scute late, apparently formed by the fusion of the epibranchial spine with two boleta tubercles (*ebt.*); the posterior one is the conical rugose mesobranchial spine (*mbs.* There are other tubercles scattered between the main groups (fig. 2), the larg ones are constant in position. There is a row of small tubercles along the ventr edge of the carapace from the intestinal group to the base of the cheliped. The are two series of large hooked setae. Each rostral horn has a double row along inner face; the second double row extends from the base of the rostral horn the epibranchial tubercle. There are also, on many of the boletate tubercles, a ri of small hooked setae under the overhanging lip of the flattened top.

The fused second and third segments of the antennal peduncle are as wide long (fig. 3a), narrowed and truncate anteriorly. The epistome is roughly tria gular, extending between the urinary segment and the buccal framework (fig. 3a an oblique ridge extends inwards from the antennal peduncle. The ventral marg of the orbit is formed by the antennal peduncle and the infra-orbital spine (*ios* or lobe behind it; the latter is separated by a distinct hiatus from the post-orbit spine (*pos.*). The pterygostomial region has a series of rounded tubercles. O the sub-hepatic region is an irregular prominence at the base of the first anter lateral spine. The third maxillipede has a dense coating of short setae, and on th ischium are two rows of rounded tubercles. The thoracic sternal region (fig. 3a has the usual groove, into which the flexed abdomen fits, deep and narrow an triangular in section. Alongside this groove are three depressions on each sid at the junctions of the fourth/fifth, fifth/sixth and sixth/seventh thoracic sternit The third and fourth sternites are not separable, and bear anteriorly a transver row of four rounded tubercles. There are patches of setae on each segment.

The abdomen is narrow, with the seven segments free and dorsal surface almo covered by setae. It broadens in the second and third and is constricted in th fourth segment; the fifth and sixth segments are of a fairly uniform width an the seventh tapers to a rounded point.

The antennal flagellum extends slightly beyond the tip of the rostrum and ha twenty segments. The chelipeds are much longer than the walking legs (fig. 1)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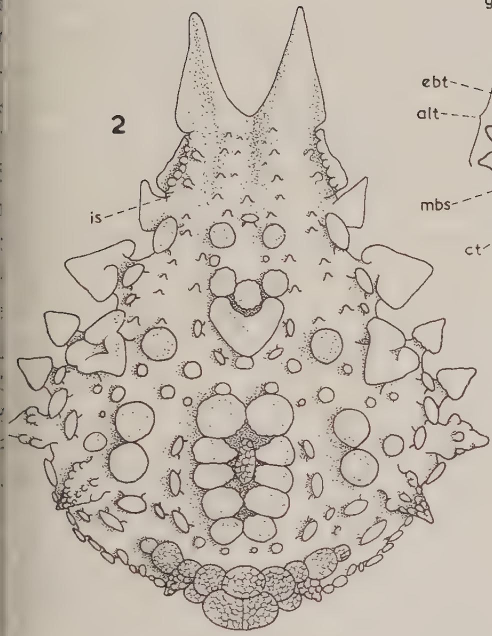
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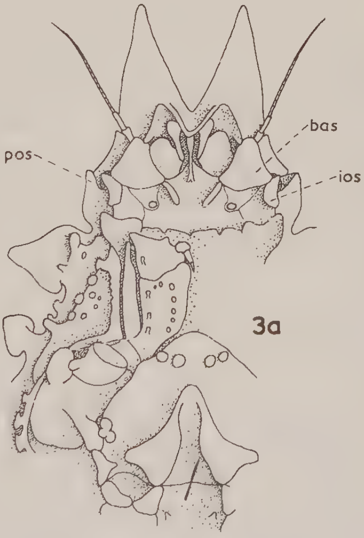
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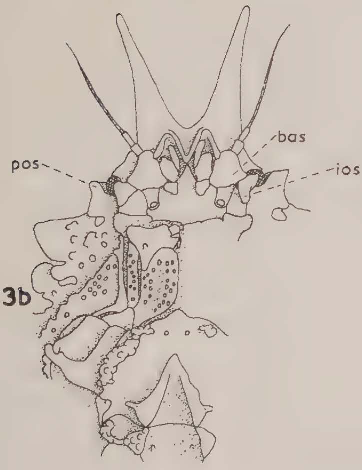
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Fig. 1, 2. *Eurynome aspera* (Pennant). 1, male, subsidiary tubercles omitted. 2, male, B.M. Reg. No. 1960. 8.30.4, dorsal aspect of carapace.

ig. 3. Right anterior part of male carapace, ventral aspect. a, *Eurynome aspera* (Pennant), male, B. M. Reg. No. 1960.8.30.4; b, *Eurynome spinosa* Hailstone, male, B.M. Reg. No. 1960.8.30.2. bbreviations: *alt*, antero-lateral tubercles; *ct*, cardiac tubercles; *ebt*, epibranchial tubercle; *gt*, gastric bercles; *ios*, infra-orbital spine; *is*, intercalary spine; *it*, intestinal tubercles; *mbs*, mesobranchial spine; *pos*, post-orbital spine.

and bear spines which are either rounded or flattened in the axis of the limb. T spines form four longitudinal rows on the merus and propodus; on the latter t dorsal row is far better developed than the others. The fingers are much short than the palmar region and set at an angle to it; they are covered with set and have black pointed tips. There are hooked setae on the postero-dorsal fa of the merus and the propodus. The walking legs decrease slightly in length fro the first to the fourth pair; they are cristate along the dorsal edge of the mer and carpus. Each propodus and dactylus has a dense covering of setae.

The first pair of pleopods (fig. 4a) have a slight S-bend. The distal end pointed, and there is a row of setae along each edge. On the inner edge there a recurved hook near the distal end, and between it and the apex are about fifte pointed spines. The second pleopod (fig. 4b) is about one third the length the first.

The measurements of the described male and the female from Port Erin in t collection of the British Museum are included in table I.

TABLE I

Measurements in mm of male and female specimens of the two species

	E. aspera		*E. spinosa*	
	♂	♀	♂	♀
	B.M. Reg. No. 1960 8.30.6	B.M. Reg. No. 1960 8.30.5	B.M. Reg. No. 1960 8.30.3	B.M. Reg No. 196 8.30.1
Carapace:				
total length incl. rostrum	17.8	16.8	13.0	12.0
length excluding rostrum	15.0	14.2	10.0	9.6
width across last ant. lat. spines	10.5	10.4	7.6	7.0
length rostrum to junction with orbit	3.8	2.8	3.2	2.6
width rostrum across base	4.1	4.0	3.0	3.0
Cheliped:				
total length from tip to sternum	31.5	15.4	20.0	10.0
length of propodus	13.0	6.2	8.2	4.5
length of merus	12.5	5.8	8.0	4.0
First walking leg:				
total length from tip to sternum	16.6	15.0	10.4	9.6

DESCRIPTION OF FEMALE. The female undergoes the moult of puberty typic of the Majidae, at which sexual maturity is reached. This causes considerab changes in the form of the abdomen and pleopods (Teissier, 1933).

The female specimen in the British Museum (Reg. No. 1960.8.30.5) h passed the moult of puberty. The rostrum is relatively shorter than in the mal and the cheliped is only slightly longer than the first walking leg. The abdome covers the whole of the thoracic sternal region; this is slightly concave and th al genital apertures are distinct. Anteriorly only traces of the transverse row of ur tubercles may be found. The abdomen is ovate in outline, with its maximum idth across the fifth segment. The form of the pleopods is normal for the mily Majidae.

For measurements of this female specimen see table I.

A female before the moult of puberty differs from the above; the abdomen es not extend right across the thoracic sternal region, but is narrower and lies a deep groove of triangular section. It does not extend forwards to the buccal amework, and in front of it is the transverse row of four tubercles as found the male (the outer pair may be absent). The genital apertures are only st visible as closed slits.

REMARKS. Within the Port Erin population there is some variation from the ove description, mainly in the form and degree of fusion of the tubercles. The -shaped row of tubercles in the gastric group may not be completely fused. In e cardiac group the row of five tubercles on each side may vary from being most discrete to being fused into a single mass; there may occasionally be a mid-terior cardiac tubercle (as is always present in *E. spinosa*), if so it is smaller than e rest and seldom fused with them. There is also considerable geographical riation: Mediterranean specimens differ quite appreciably from British ones, t seem to be of *aspera* form.

A juvenile specimen of about 3 mm carapace length (fig. 5a) differs con-derably from the adult. The tubercles are either spines or rounded knobs, and sion has not occurred in the various groups. However, all of the principal tuber-es may be identified. Each rostral horn has a row of spines along its outer edge. he intercalary spine is relatively much better developed, while the eyestalk nnot yet be fully withdrawn into the orbit.

In the female growth of the cheliped is more or less isometric; in the male owever its growth is positively allometric.

The following size limits were found in the Port Erin population.

argest male:	Carapace length (including rostrum)	22 mm.
argest post-puberty female:	,, ,, ,, ,,	19 mm.
mallest post-puberty female:	,, ,, ,, ,,	14 mm.

HABITAT. Off Port Erin the species is most abundant on muddy sand (30-80); only very few specimens were obtained on coarse ground.

DISTRIBUTION. Because previously *E. spinosa* has not been separated from *E. pera,* records of the occurrence of the latter are not reliable. I have identified as *. aspera* specimens from the following areas: British Isles (Irish Sea, Channel), eland, Norway, Portugal, N.W. Africa (off Rio de Oro) and in the Mediter-nean (France, Italy, Spain and Algeria).

Eurynome spinosa Hailstone (figs. 3b, 4c, d, 5b, 6, 7)

335 — *Eurynome spinosa* Hailstone: 549-550, fig. 47.
861 — *Eurynome tenuicornis* Malm: 619.
908 — *Eurynome aspera tenuicornis* Lagerberg: 94, pl. 4 fig. 3.

There do not appear to be any types in existence. The following specimens from the Port Erin material were deposited in the British Museum (Nat. Hist.) as characteristic examples of the species: one male, Reg. No. 1960.8.30.3; one male, Reg. No. 1960.8.30.2; one female, Reg. No. 1960.8.30.1.

Description of male (fig. 6). The first listed specimen (Reg. No. 1960.8.30.3), a normal mature male from Port Erin, is described. The shape of the carapace, pattern of tubercles and form of appendages are generally similar to those of *E. aspera* (Pennant). The outline of the carapace is rounded rather than triangular, due to the expansion of the first antero-lateral tubercle.

The rostral horns are long and narrow, the width across the base of the rostrum being less than the length from the tip to the junction with the orbit. In the present specimen the rostral horns are more or less parallel, but in some (e.g. the specimen represented in fig. 6) they may diverge distally. There is no hiatus between the supra-orbital lobe and the post-orbital spine, and only a trace of the intercalary spine remains at the base of the junction between them.

Of the antero-lateral projections, the anterior one is a flattened triangular plate fused anteriorly with the post-orbital spine; the other three are blunt capitate tubercles. The median tubercle of the gastric group is bluntly conical and granular with around it a U-shaped row of seven boletate tubercles, slightly fused. Behind the gastric group in the midline is the cardiac group, with a central blunt granular prominence; on each side is a crescent of five boletate tubercles, and there is also a mid-anterior one (the latter is usually absent in *E. aspera*). Joining the gastric and cardiac groups is a tubercle which probably represents the urogastric spine. The intestinal group contains the same tubercles and spines as in *E. aspera*, but they are discrete and not fused into a crescent across the rear of the carapace. The epibranchial spine is blunt and granular, and partly fused with a pair of discoid tubercles. The mesobranchial spine is conical and granular. Scattered over the carapace are other tubercles of which the larger ones may be correlated with those in *E. aspera*. The tubercles along the ventral edge of the carapace are small and numerous, tending to form a double rather than a single row. In general the tubercles of *E. spinosa* are smaller, less erect and more discrete than those of *E. aspera*.

The basal segment of the antenna and the epistome (fig. 3b) are much as in *E. aspera*. The epistome has a triangular prominence rather than a ridge adjacent to the antennal peduncle. The pterygostomial region has a number of rounded tubercles forming a double row along its outer margin. The sub-hepatic region has an irregular tubercle anteriorly and a number of other smaller rounded ones. The third maxillipede has a scattered coating of setae, and many small tubercles on the ischium and exopodite. In the thoracic sternum the groove for the abdomen, and the depressions alongside it, are as in *E. aspera*. The transverse row of four tubercles across the third thoracic sternite (the suture between the third and fourth sternites is visible) is poorly defined; the median pair is reduced, while the outer

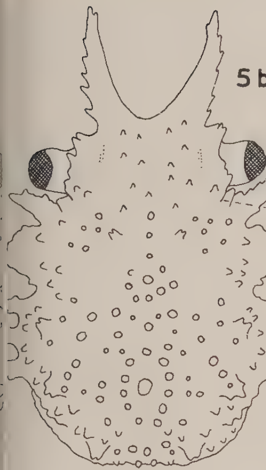
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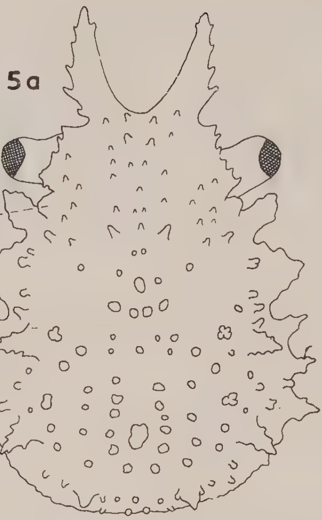
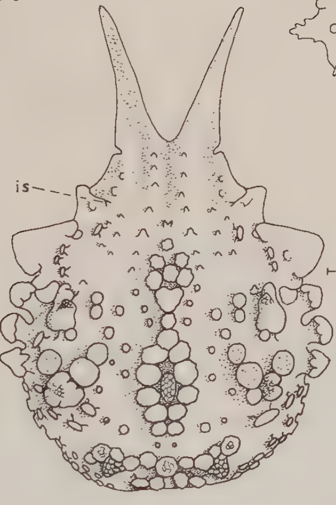
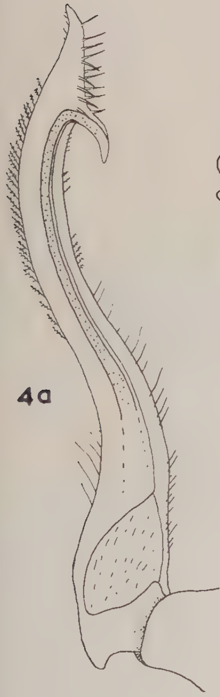
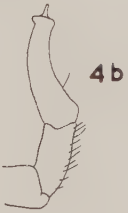
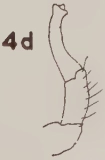
Fig. 5

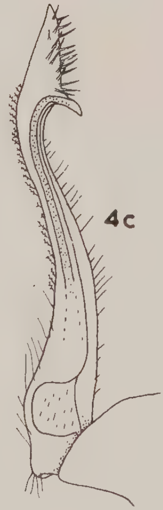












4. Pleopods of male. a, b, *Eurynome aspera* (Pennant); c, d, *Eurynome spinosa* Hailstone; a, c, abdominal face of right first pleopod; b, d, thoracic face of right second pleopod.

Fig. 5. Juvenile specimens. a, *Eurynome aspera* (Pennant); b, *Eurynome spinosa* Hailstone.

6. *Eurynome spinosa* Hailstone, male, B.M. Reg. No. 1960.8.30.2. Dorsal aspect of carapace

Abbreviation: *is*, intercalary spine.

pair is mixed with a number of other tubercles around the edge of the sternu
The abdomen is like that of *E. aspera.*

The antennal flagellum just reaches the tip of the rostrum, and has 22 segme
The chelipeds of the two species are very similar, those of *E. spinosa* havi
slightly fewer and smaller spines; in the males however, those of *E. spinosa*
relatively longer (fig. 7). The crest on the merus and carpus of the walking l
tends to have a smooth edge, rather than the undulating one normal in *E. aspe*

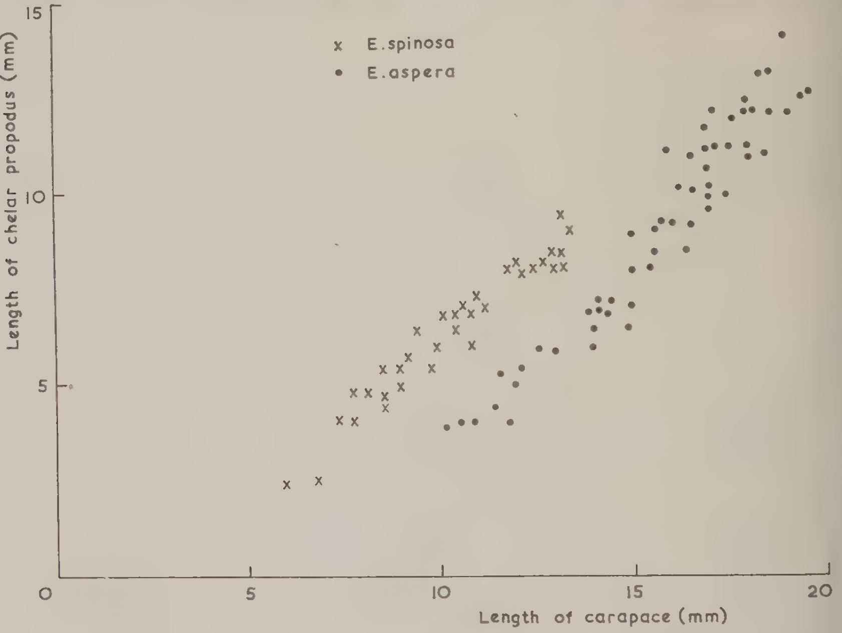


Fig. 7. Relative length of the chelar propodus in males of *Eurynome aspera* and *E. spinosa.*

The first pleopod (fig. 4c), though similar to that of *E. aspera*, differs in t
the hook is straighter and less recurved, and the number of spines is great
about twenty. The second pleopod is as represented in fig. 4d.

For measurements of this male specimen see table I.

Description of female. The female undergoes the moult of puberty in
same way as does that of *E. aspera.*

The female specimen (Brit. Mus. Reg. No. 1960.8.30.1) is a normal p
puberty specimen collected at Port Erin. The rostrum is shorter and broader
in the male, and the notch between the horns is wider. The width across the
is greater than the length from tip to junction with orbit. The outline of
carapace is more rounded than in the male. The form of the abdomen and stern
is as in *E. aspera*; there is no trace of the tubercles on the third thoracic stern
The genital apertures are semicircular, with the straight edge on the outer si
For the measurements of this specimen see table I.

The females before the moult of puberty show the same differences fr
those after this moult as in *E. aspera. E. spinosa* is a smaller species, and

ult of puberty occurs at a smaller size. Thus *E. spinosa* has been found ovigerous ile only 6 mm long, but the smallest ovigerous *E. aspera* was 14 mm long.

REMARKS. Within the Port Erin population there is a considerable variation the form of the tubercles. The boletate tubercles may be erect or depressed and sely applied to the carapace. There is also a variable amount of fusion; in the stric group the seven peripheral tubercles may be free, but often the three sterior ones are fused (as in fig. 6). In the cardiac and intestinal groups the ercles may be quite discrete or partly fused, but they do not have the degree of ion normal in *E. aspera.*

The juveniles (3 mm carapace length) differ from the adult in the same racters as do those of *E. aspera.* All the main tubercles can be identified at s size (fig. 5b).

The growth of the chelipeds of the female is approximately isometric; that of male is positively allometric.

The following size limits were found in the Port Erin population.

gest male:	Carapace length (including rostrum)	13.4 mm.
gest post-puberty female:	,, ,, ,, ,,	12.0 mm.
allest post-puberty female:	,, ,, ,, ,,	6.0 mm.

HABITAT. In the Port Erin area the species occurs mostly on coarse grounds — nes, shell and broken shell (20-40 m) and also on the *Modiolus* bed (Jones, 51) in 60 m. There is also a record of three small specimens from under lime- ne ledges in the intertidal zone at Port St. Mary, Isle of Man (Marine Fauna the Isle of Man, second edition, in press). They are recorded as *E. aspera,* I have examined the specimens and they are definitely *E. spinosa.*

DISTRIBUTION. I have examined specimens from the Isle of Man, Salcombe evon), Luce Bay (Scotland) and Birterby Bay (Ireland). There is also a record m Sweden (Malm, 1861).

DISCUSSION

Hailstone's original description of *E. spinosa* is based on a specimen 3 mm long, ich he separates from *E. aspera* because the rostrum is spinous and the orna- ntation of the carapace is a series of spines. However we have seen above that se are juvenile characters possessed equally by both species, and so separation this basis is not valid. However he gives a figure, and if this is compared with cimens of the same size, the pattern of tubercles (especially the gastric and diac groups) resembles not that of *E. aspera* but that of the other species found Port Erin; the latter should therefore be known as *E. spinosa.*

While it is possible to separate juvenile specimens, this is not the case with first stage zoea. Berried females were kept until the eggs hatched, and Dr. I. Williamson of the Marine Biological Station, Port Erin, examined the first ge zoea, but could find no difference between the two species. An unsuccessful empt was made to rear the larvae further.

In the larger specimens there are many differences; it is perhaps simples use the pattern of tubercles on the carapace in separating the two species. If th is no mid-anterior tubercle in the cardiac group, then the specimen is defini *E. aspera*. *E. spinosa* always has this tubercle, but so do a few specimens o *aspera*. These latter can be separated by examining the gastric and intestinal gro where the greater fusion of the tubercles will at once distinguish them fr *E. spinosa* (cf. figs. 2, 6).

Acknowledgments: My thanks are due to Dr. I. Gordon of the British Museum (Nat. H for help in preparing the descriptions and for correcting the manuscript. I must also thank Dr. I Holthuis of the Rijksmuseum van Natuurlijke Historie, Leiden, for help with the literature, Mr. D. Eggleston of the Marine Biological Station, Port Erin, for collecting part of the M material. This work was carried out while holding a D.S.I.R. Postgraduate Studentship.

ZUSAMMENFASSUNG

Aus dem europäischen und nordafrikanischen Gebiet war bisher nur eine *Eurynome*-Art bek nämlich *E. aspera* (Pennant). Die Gegenwart einer zweiten Art, *E. spinosa* Hailstone, wird n gewiesen. Beide Arten werden ausführlich beschrieben und abgebildet.

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THE LIFE-CYCLE OF *PELTOGASTERELLA* (CIRRIPEDIA, RHIZOCEPHALA) [1]

BY

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All the known Rhizocephala except a few species belonging to the family onidae have been described as hermaphroditic animals. In 1958, Ichikawa and nagimachi reported that *Peltogasterella gracilis* (Boschma) (syn. *Peltogasterella ialis* Krüger; cf. Reischman, 1959) is not a hermaphrodite, but is structurally emale. The "testes" of this rhizocephalan are actually female organs which ction as a reservoir to hold the cells of the larval cypris male. Ichikawa and nagimachi suggested that the "testes" should be called "spermathecae" (Ichika- and Yanagimachi, 1958) or "cypris-cell receptacles" (Ichikawa and Yanagi- chi, 1960).

Recently, the following facts have been elucidated in *Peltogasterella gracilis*:) An adult female produces exclusively either large eggs (160-170 μ in diam- r) or small eggs (140-150 μ in diameter). Females on a single host-crab are formly either "large-egg-producing" or "small-egg-producing." (2) The large s develop into large larvae, while the smaller eggs develop into small larvae. the nauplius stage, the two types of the larvae are distinguishable only by ir size. In the cypris stage, however, the larvae differ not only in size but also structure. The most notable structural difference is found in the antennules ich serve as organs of attachment. (3) The large cypris (300-340 μ in body gth) affix to the mantle opening of the juvenile females of *P. gracilis,* while smaller cypris (230-260 μ in body length) attach at the base of setae on the t's body. The large cypris function as larval males, while the smaller cypris destined to become adult females.

The details of the above-mentioned facts are reported elsewhere (Yanagimachi, 51). The present paper describes a new concept of the life-cycle of *Peltogasterella cilis* (Boschma) based on the nature of sex determination in this species . fig. 1).

A female (A) infesting a host-crab produces large eggs. These eggs are fer- zed inside the maternal mantle cavity by spermatozoa from the cypris-cell eptacles. The zygotes develop into large nauplii. The nauplii (B) leave the ternal mantle cavity and become a part of surface plankton. After successive moults they metamorphose into large cypris (C). The cypris searches for juvenile females of the same species and attaches itself to the mantle opening a female (D). The cellular mass of the cypris is now injected through one of antennules into the mantle cavity of the juvenile female (D_1-D_3). The cyp

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[1] Contribution No. 475 from the Zoological Institute, Faculty of Science, Hokkaido University, poro, Japan.

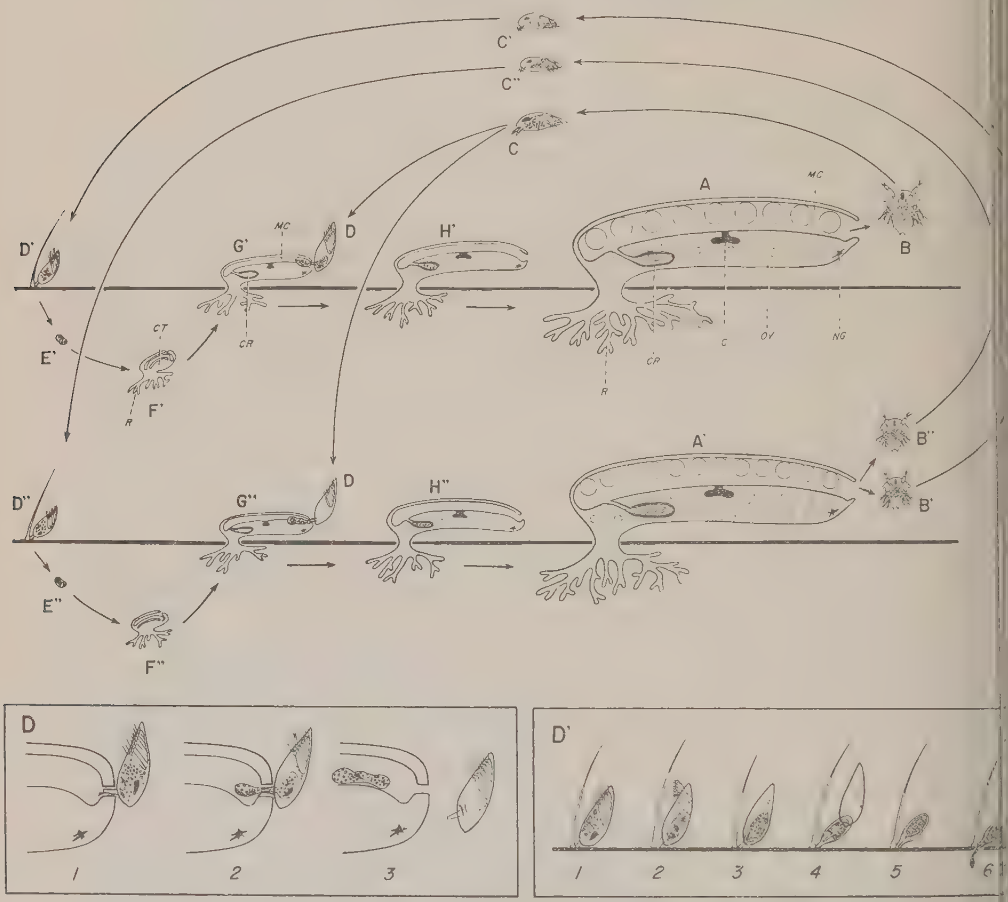

Fig. 1. Diagram of the life-cycle of *Peltogasterella*. Explanation in the text. *C*, colleteric gla *CR*, cypris-cell receptacle; *CT*, central tumor; *MC*, mantle cavity; *NG*, nervous ganglion; *OV*, ov *R*, root system.

cell mass migrates posteriorly into the cavity and enters one of the paired cyp cell receptacles (Ichikawa and Yanagimachi, 1958).

A female (A′) on a different host may produce exclusively small eggs. Wh these eggs are fertilized by spermatozoa they give rise to small nauplii. The sm nauplii (B′ and B″) undergo successive moults and metamorphose into sm cypris (C′ and C″). The cypris seeks out a young host and attaches itself by o of its antennules to the base of a seta on the carapace of the host (D′ and D″ Soon after fixation the bivalve shell with the larval thoracic limbs is cast of e internal cell mass is covered with a thin new layer of chitin (Veillet, 1952). us, the cypris has metamorphosed into the kentrogon, a small oblong sac en- ed in chitin ($D'_{1\text{-}4}$). A dart-shaped tube differentiates in the anterior portion the cell mass. This tube pierces the integument of the host. A mass of undif- entiated cells passes through this tube into the body of the host ($D'_{5\text{-}6}$). The ris-cell mass is carried by the blood stream to the abdomen of the host. It now ws rapidly and establishes a central tumor with a ramifying root system. The lage of the external sac forms within the central tumor. As the central tumor ws, it presses against the abdominal wall of the host. This contact causes a crosis of the parietal muscle and the epidermis and a softening of the chitin. hen the host moults, the parasite emerges through an opening to the exterior, root system remaining inside of the host. Thus, the parasite becomes partially parasitic and partially endoparasitic. In this state the juvenile parasite (a nale) awaits the arrival of a larval male (large cypris). When the male attaches lf to the juvenile, it injects its cellular contents into the mantle cavity (D). e cell mass migrates to one of the cypris-cell receptacles. The juvenile now ws rapidly and soon reaches sexual maturity ($G' \rightarrow H' \rightarrow A$ and $G'' \rightarrow H'' \rightarrow A'$). e larval male cells implanted in the cypris-cell receptacles multiply rapidly and ferentiate into spermatozoa. An adult female produces several batches of larvae. ter the last batch of larvae has been released, the external sac withers and ps off. The root system remains within the host and may develop new ernal sacs.

A salient feature of *Peltogasterella gracilis* is that it always occurs gregariously a single host. It has been a problem to zoologists whether numerous and arently separate individuals on a host are the product of a single cypris larva of numerous larvae. Smith (1906) suggested that the multiple individuals of *togasterella sulcata* (Lilljeborg) (syn. *Peltogaster socialis* F. Müller; cf. Reisch- n, 1959) could be derived from a single cypris larva by a process of poly- bryony (or budding) of the endoparasitic central tumor and its root system. *Peltogasterella sulcata* (syn. *Chlorogaster sulcatus*; cf. Reischman, 1959), Pérez 931) demonstrated that the numerous individuals which emerged successively m the host's abdomen arise from the buds formed on a root system. Thus, s probable that the adult females of *Peltogasterella gracilis* on a host result from ingle cypris larva. The diagram of figure 1 is to be revised when the question multiple or single infestation is settled.

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SOMMAIRE

ne femelle adulte de *Peltogasterella gracilis* (Boschma) produit exclusivement soit de grands s, soit de petits œufs. Les grands œufs se développent en grandes larves dont les fonctions sont es des mâles larvaires. Les petits œufs donnent naissance à de petites larves qui se développent femelles adultes. Le cycle biologique est représenté sous forme de diagramme dans la figure 1.

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THE LARVAE OF *SPIRONTOCARIS* AND RELATED GENERA (DECAPODA, HIPPOLYTIDAE)

BY

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INTRODUCTION

The great majority of Western European and American authors have followed
man (1906) in applying the generic name *Spirontocaris* Bate to all adult
ppolytidae in which the mandible has an incisor process and a palp of two
ments and the carpus of the second leg is of 6 or 7 segments, and also to the
cies *cranchii* (Leach), which has no mandibular palp (Lebour, 1936). Most
ssian authors, on the other hand, have used the name *Spirontocaris* in a more
tricted sense, and Holthuis (1947) adopted many features of the Russian
ssification in dividing *Spirontocaris* s.l. into six separate genera. Larvae belon-
g to five of these six genera have been described, although in the majority of
es only the first zoeal stage has been obtained. In the present paper descriptions
given of all larval stages of five species of *Spirontocaris* s.l. from the Irish
, and the Firth of Clyde, the published information on the other larvae is
nmarised, and the taxonomy of the group is discussed in relation to larval
racters.

The generic nomenclature of Holthuis (1947) is employed throughout the
criptive part of the paper. The terms "zoea" and "megalopa" are used in the
ad sense employed by D. I. Williamson (1957a), and the ambiguous terms
st-larva" and "post-larval" are avoided. The stages following the megalopa
hich are non-larval) are termed "young stages". The length of a larva is taken
m the tip of the rostrum to the end of the telson, excluding the telson spines.

Spirontocaris Bate

Spirontocaris spinus (Sowerby) (fig. 1 a, b, d-r)

rost, 1936: 16, fig. 3 (as "*Spirontocaris* A").
I. Williamson, 1957b: 4, figs. 17-20 (stages I and V).

This species was hatched at the Marine Biological Station, Port Erin, on 6 April
54, and several of the larvae from this hatching reached the 2nd zoeal stage.

) Marine Station, Millport, Scotland.
) Marine Biological Station, Port Erin, Isle of Man.

Planktonic larvae have been collected from the Irish Sea and, although rare most years, were fairly common in the spring of 1956. The megalopa has b obtained from the last zoea on two occasions and one of these megalopae mou to the 1st young stage.

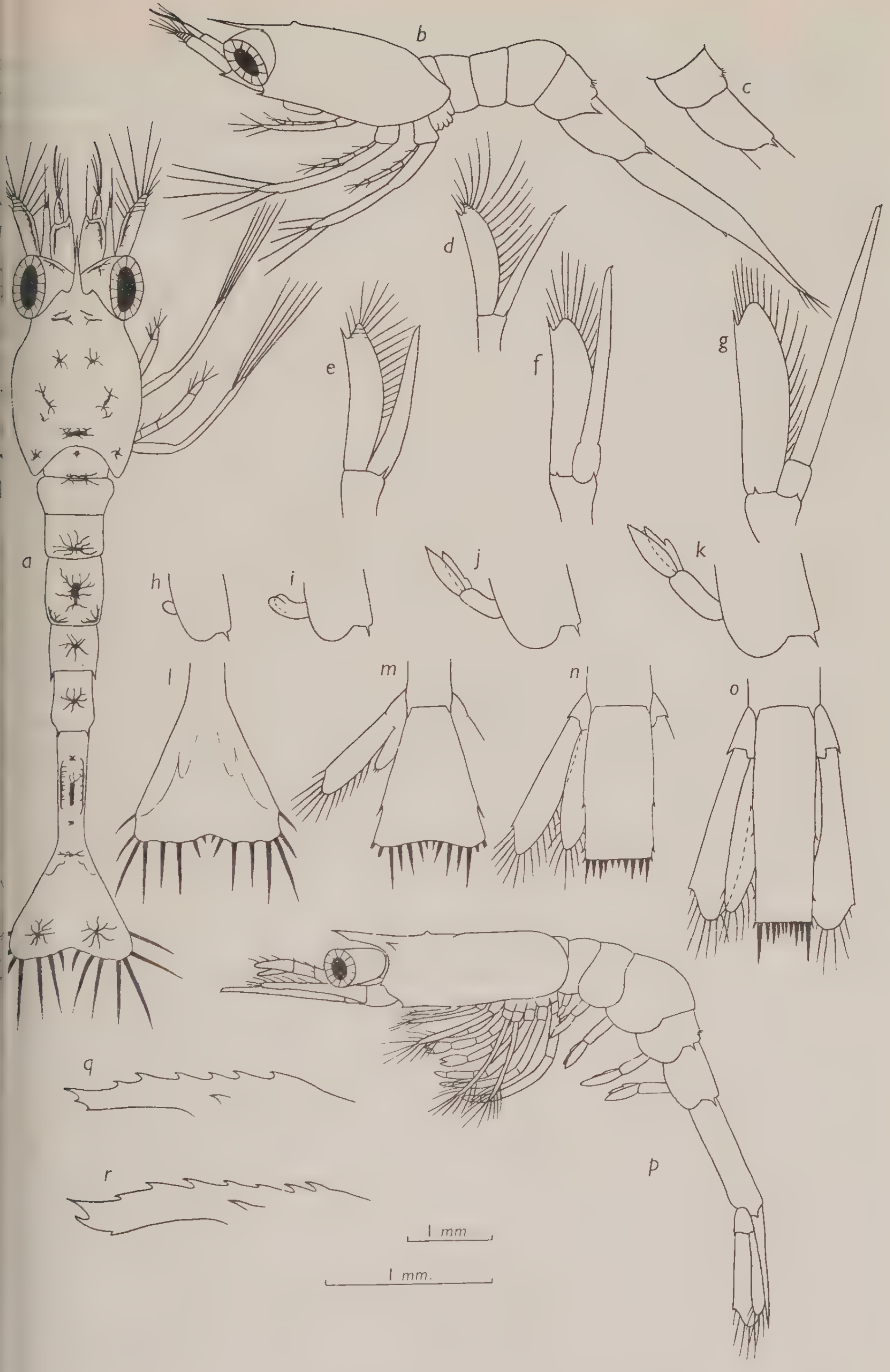
ZOEAL STAGES. There are five zoeal stages. In each, the rostrum is promin and pointed and reaches to about ¾ the length of the antennular peduncle deepens slightly in the later stages (fig. 1p) but does not develop teeth until megalopa stage. The supra-orbital spine on each side is rudimentary in stag and clearly defined in the subsequent stages, and there is a medio-dorsal tube on the anterior carapace. Apart from the pterygostomian spines, the ventral a posterior margins of the carapace are smooth. The 4th abdominal somite bear dorsal tuft of short setae and a lateral spine on each side of the posterior marg There is a similar pair of lateral spines, but no setae, on the 5th somite, and anal spine is present from stage I. There is no outer seta on the maxillule (D Williamson, 1957b), and peraeopods 3-5 are without exopods in all stages.

The chromatophores are distributed as in fig. 1a. The majority appear yel in reflected light and brown in transmitted light, each with a less prominent p component, but the small median chromatophore on the posterior thorax and elongated median one on the 6th abdominal somite are wholly pink. There is appreciable change in coloration during the zoeal stages.

Stage I (fig. 1 a, b). Length about 4.3 mm. The peduncle of the antenn is unsegmented; the inner ramus is represented by a small prominence bearin plumose seta, and the outer by a single segment ending in four aesthetascs. Th is an inner ventral spine on the antennal peduncle at the base of the endop and the endopod ends in a spine and a seta. The scale, which extends about as as the spine on the endopod, has four segments defined at its distal end; it be an outer seta at the base of the segmented portion but no spine. Functio natatory exopods are confined to the three pairs of maxillipeds. Rudiments of five pairs of peraeopods are present, and the first two pairs are biramous. Th are no abdominal appendages.

Stage II (fig. 1 d, h, l). Length about 5.2 mm. The antennular peduncle jointed at about ¾ its length, and there is a ventral spine at about ¼ its leng The inner ramus has a basal articulation and is about half as long as the ou The spine at the end of the antennal endopod is inclined away from the sc and the seta has disappeared. Two or three segments can be distinguished at tip of the scale but the segmentation is indistinct, and the outer seta is repla by a short spine. The endopod and scale are of similar length. The peraeopod b are larger than in stage I, and small uniramous pleopod buds are present somites 2 to 5. The telson bears the small additional pair of spines usual in t stage.

Stage III (fig. 1 e, i, m). Length about 5.7 mm. The carapace bears a sm antennal spine, beneath the eye, on either side. The antennule shows little chan apart from the development of additional setae. The spine at the tip of t



1. a, b, d-r, *Spirontocaris spinus* (Sowerby); c, *S. lilljeborgii* (Danielssen). a, b, stage I. a,
al, showing chromatophores; b. lateral. c, stage I, abdominal somites 4 and 5, lateral. d-g,
nna, ventral. d, stage II; e, stage III; f, stage IV; g, stage V. h-k, 5th abdominal somite and
pod, lateral. h, stage II; i, stage III; j, stage IV; k, stage V. l-o, telson and uropods, dorsal.
age II; m, stage III; n, stage IV; o, stage V. p, stage V (= last zoeal stage), lateral. q, r,
um, lateral. q, stage VI (= megalopa); r, stage VII (= 1st young). All at the higher magnification, except p.

antennal endopod is shorter, the segmentation at the tip of the scale is less disti and the endopod and scale are still of similar length. The peraeopod buds larger and indistinctly segmented, the first two pairs end in incipient che and their exopods are still without setae. The pleopod buds on somites 2-5 biramous and there are minute uniramous buds on somite 1. The uropods free; the exopod of each bears about 12 setae and there is a slight indication of articulation at its base; the endopod is only about half as long as the exop bears only 3 very short setae and has no trace of a basal articulation. The tels which now articulates with the 6th somite, is rather narrower than in stage but its posterior width is still more than twice its anterior width.

Stage IV (fig. 1 f, j, n). Length about 6.9 mm. There is a small ventral sp at the base of the antennal scale, and that at the base of the endopod persi The endopod is distinctly longer than the scale, and one segment is partly form at its base. The scale is no longer segmented. The peraeopods are clearly s mented, and the exopods are setose and functional. Both rami of each pleop and uropod articulate with the protopod. The pleopods are pointed, and e except the small first pair shows a small appendix interna. The uropods ha many setae on each ramus and the endopods are about 5/6 the length of exopods. The telson is practically rectangular and just over twice as long as bro

Stage V (fig. 1 g, k, o, p). Length about 7.9 mm. The antennal endopo about 1.5 times as long as the scale, the basal segment is fully formed, and small spine at the distal end is slightly sub-terminal. There is a develop pleurobranch at the base of each peraeopod, and the carpus of the 2nd peraeo is still entire. The pleopods are not functional but they bear a few very sl setae. The endopod of each uropod is almost as long as the exopod, and the tels which remains rectangular, is about 3.5 times as long as broad.

MEGALOPA. The length is about the same as in the last zoeal stage. The rostr (fig. 1 q) is larger and bears 7 dorsal teeth (including the terminal one) a 2 antero-ventral teeth. There is a distinct dorsal tooth on the posterior margin the 3rd abdominal somite; the dorsal tuft of short setae on the 4th som persists, but the lateral spines on both the 4th and 5th somites have disappear There is a small ventro-lateral spine on the posterior margin of the 5th som on either side. The inner antennular flagellum consists of 5 segments and outer is incompletely segmented. The antennal flagellum is more than half long as the body and fully segmented. The carpus of peraeopod 2 is sub-divi into 6 segments. All the thoracic exopods are shorter than in the last zoeal sta those on the maxillipeds are still setose, but those on peraeopods 1 and 2 without setae. There are very small epipods on peraeopods 1-3 and the pleu branchs are well developed. The pleopods are now fuctional swimming appendag and both rami are setose. The first pleopod remains much smaller than the othe

There are very many opaque deep-yellow chromatophores on all parts except t antennal flagellum and peraeopods, and there is a small red chromatophore on t nt of each eyestalk, about 9 on the dorsal carapace and one, dorsally, on each dominal somite.

FIRST YOUNG STAGE. This stage is also about 8 mm long, and differs from the galopa in having a deeper and more curved rostrum with an additional dorsal th (fig. 1 r). There is still only one supra-orbital spine, as opposed to two in mature animal. The exopods have disappeared from the peraeopods, and the pods are larger.

REMARKS. Frost (1936) gave a brief description of larvae which she included in *pirontocaris* A", and she illustrated a specimen of 8 mm which shows very close eement with stage IV of *S. spinus*, except that no dorsal setae were shown on 4th abdominal somite. On this point the larvae of ,,*Spirontocaris* A" appear to emble *S. phippsii* (see p. 192) rather than *S. spinus*, but these setae are easily rlooked, and the lengths of the lateral spines on the 4th and 5th abdominal nites and of the telson spines seem to be in better agreement with *S. spinus* than h *S. phippsii*.

Spirontocaris lilljeborgii (Danielssen) (fig. 1 c)

our, 1937: 101, fig. 1 (stage I only, as *S. spinus* var. *lilljeborgi*).
I. Williamson, 1957b: 4, figs. 14-16 (stage I only).

Lebour's (1937) account was based on specimens hatched at the Dove Marine oratory, Cullercoats, by Dr. H. O. Bull, and reference is also made to specimens ched at Millport by Mr. R. Elmhirst. Further hatchings were obtained at the llport Laboratory in April 1952 and again in April 1957, and all five zoeal ges have been collected from plankton from the Firth of Clyde. Stage II, the galopa and the 1st young stage have each been obtained from the previous stage the laboratory.

The larval and young stages of *S. lilljeborgii* are very similar to those of *spinus*, and the only differences found were in the armature of the abdomen. ere are no lateral spines on the 4th abdominal somite in any of the zoeal stages *S. lilljeborgii* and the spines on the 5th somite tend to become smaller in the r stages. One specimen in the last zoeal stage had no trace of abdominal spines, others in the same stage had small spines on the 5th somite. The megalopa and young stage differ from the corresponding stages of *S. spinus* in lacking a sal tooth on the posterior margin of the 3rd abdominal somite.

Lebour (1937) stated that in stage I of *S. lilljeborgii* the antennal scale was not mented, and she made no mention of the dorsal tuft of setae on the 4th lominal somite. All the stage I specimens examined by us show both the seg- ntation of the scale and the dorsal tuft of setae on the abdomen, but both char- ers are less obvious in preserved material and in some cases the setae may break . A specimen in stage I in our possession, from plankton collected by Capt. D. Maddrell off Portland, Maine, U.S.A., shows only two dorsal setae on the somite.

Adult specimens intermediate between *S. spinus* and *S. lilljeborgii* have been

reported (Kemp, 1910; Lebour, 1937), but all the larvae in our collections
be assigned definitely to one species or the other.

Spirontocaris phippsii (Krøyer) [= *S. turgida* (Krøyer)]

? Stephensen, 1916: 256 (part), fig. 6 (not 7) (as "*Spirontocaris*-larva Nr. 2, *Sp. turgida?*").
? Stephensen, 1935: 54 (part) (as "*Spirontocaris*-larva No. 2, ? *Sp. turgida* (Krøyer)").
? Stephensen, 1935: 55 (as "*Spirontocaris*-larva No. 2B").

Larvae of this species have not been hatched in the laboratory, but a specim
in stage II taken by Capt. G. D. Maddrell off Portland, Maine, U.S.A., alm
certainly belongs to it. This larva shows a marked resemblance to *S. spinus* in
same stage, including the absence of exopods from peraeopods 3, 4 and 5, but
differs from that species in being rather larger (6.0 mm), in having rather mor
prominent spines on the 4th and 5th abdominal somites and no dorsal tuft of se
on the 4th somite, and in having the telson rather broader and the 7th pair
telson spines about ¾ (as opposed to ¼) the length of the 6th pair. The prese
of exopods on the anterior two pairs of peraeopods only is a feature of larvae
Spirontocaris (s.s.), not known in any other genus of the *Spirontocaris* group,
the only species of *Spirontocaris* recorded from the east coast of the U.S.A.
S. spinus, *S. lilljeborgii* and *S. phippsii* (cf. Holthuis, 1947). As the larva sho
differences from each of the two former species it seems likely to belong
S. phippsii.

Stephensen (1916, 1935) included in his "*Spirontocaris*-larva No. 2" specim
with dorso-lateral spines on the 4th and 5th abdominal somites, some of which h
exopods on peraeopods 1 and 2 while others had exopods on peraeopods 1, 2 and
Some of his statements imply that the exopod on peraeopod 3 was restricted to
later stages, but his figure of stage III (Stephensen, 1916, fig. 6, as "1. stage"
with exopods on peraeopods 1 and 2 only, shows all the peraeopods as large a
partly segmented. It seems highly improbable that a further pair of exopods wou
have made their appearance at a later stage. The late appearance of exopods on t
3rd pair of peraeopods is also irreconcilable with Stephensen's (1935) record of
specimen of this "species" in the last stage, in which these exopods were abse
In our opinion Stephensen's "*Spirontocaris*-larva No. 2" included two species,
with exopods on peraeopods 1 and 2, which was probably a species of *Spiron*
caris s.s., and one with exopods on peraeopods 1-3, which was probably a spec
of *Eualus*. *S. spinus*, *S.lilljeborgii* and *S. phippsii* are recorded from Greenla
waters (Holthuis, 1947), but *S. lilljeborgii* must be ruled out because of its la
of spines on the 4th abdominal somite. The specimen illustrated in stage I
(Stephensen, 1916, fig. 6) showed greater development of both the antennae a
the uropods than do British specimens of *S. spinus* in the same stage, but these d
ferences may be environmental rather than specific. However, as there was no me
tion of the short setae known to be present on the dorsal side of the 4th abdomi
somite of larvae of *S. spinus*, and as adults of *S. spinus* were rare in Stephense

lections, the larvae in question seem likely to belong to *S. phippsii.* The other cies included by Stephensen in "*Spirontocaris*-larva No. 2" may have been *ilus macilentus* (Krøyer), whose larvae are undescribed. Larvae of the other cies of *Eualus* recorded from Greenland (*E. gaimardii* and *E. fabricii*) probably k spines on the 4th abdominal somite (see p. 194 and p. 203).

The single specimen of "*Spirontocaris*-larva No. 2B" (Stephensen, 1935) was ed to agree well with the last stage of "*Spirontocaris*-larva No. 2" except that ad no exopods on the 3rd pair of peraeopods. The information given does not mit any distinction from the specimen in the last stage, mentioned above, which lacked exopods on the 3rd pair of peraeopods but which Stephensen included '*Spirontocaris*-larva No. 2". If his "larva No. 2B" really belonged to a separate cies, this seems most likely to have been *S. spinus.*

Lebbeus White

Lebbeus polaris (Sabine)

yer, 1842: 245, pl. 6 figs. 120-132 (late embryo only, as *Hippolyte polaris*).
C. Williamson, 1915: 381, figs. 89-92 (late embryo only, as *Hippolyte polaris*, after Krøyer).
ephensen, 1916: 254, fig. 5 (? stage II, as "*Spirontocaris* larva Nr. 1, 1. free stage of *Sp. polaris?*").
ephensen, 1935: 53 (part) (as "*Spirontocaris*-larva No. 1, ? *Sp. polaris* (Sabine)").
. I. Williamson, 1957 b: 4, figs. 10-13 (? stage II, after Stephensen, 1916).

The only described larva of this species whose identification is quite certain is t which Krøyer (1842) dissected from a ripe egg. The antennule and antenna e drawn pointing ventrally as in a typical prezoea, but all the other features were se of a zoea, and it must be assumed that the prezoeal cuticle was removed as l as the egg membranes. The larva was in a very advanced state, with all ap- dages except uropods present and segmented. Small dorso-lateral spines were wn on the 4th and 5th abdominal somites in dorsal view but were omitted in ral view. The three pairs of maxillipeds bore large setose exopods but there no trace of exopods on any of the peraeopods.

tephensen (1916) described a planktonic specimen of 8 mm from southern enland which he regarded as a stage I zoea of *Spirontocaris polaris* (= *Lebbeus aris*). It agreed with Krøyer's specimen in having small dorso-lateral spines on 4th and 5th abdominal somites and in lacking exopods on the peraeopods, but the appendages were larger and better developed, supra-orbital spines were sent and there had probably been 8 + 8 telson spines, although several of these e broken off. Developing uropods were visible inside the telson. These features imply that Stephensen's specimen was in stage II. The peraeopods were ap- aching adult form, with the carpus of the 2nd already partly subdivided, and opods 2-5 each had a well developed appendix interna. This suggests that the cimen was probably in the last, or perhaps penultimate, zoeal stage, and that species passes through only 2, or perhaps 3, zoeal stages. From the advanced dition of the peraeopods in this specimen it appears highly improbable that exopods could have developed on any of them at a subsequent stage. Compl suppression of exopods on the peraeopods in the zoeal stages is rare in the Carid but it is known in *Cryptocheles* and *Bythocaris* (Hippolytidae) and in *Scle crangon* (Crangonidae) (Sars, 1912, 1890). These three genera resemble *Lebb* in having abbreviated development, but differ in that their larvae are not pelagi

Stephensen (1935) recorded a number of specimens from west Greenla agreeing with that he had described in 1916, and some others with exopods peraeopods 1 and 2 which he regarded as later stages of the same species. Howev as none of the specimens had free uropods none could have been later than stage (Gurney, 1942: 55), also the so-called "older stage" was only 8 mm long, co pared with 8-10 mm for the "youngest stage", and both peraeopods and pleop were stated to be shorter in the "older stage". It therefore seems almost certain t the specimens with exopods on peraeopods 1 and 2 belonged to another speci

Lebbeus groenlandicus (Fabricius)

? Stephensen, 1935: 54 (as "*Spirontocaris*-larva No. 1A").

Under the name "*Spirontocaris*-larva No. 1A", Stephensen (1935) included f specimens of 8-11 mm, all without abdominal spines, without exopods on peraeopods and without free uropods. The rostrum was longer and more slen than in the larvae attributed to *L. polaris*. He regarded his "larva 1A" as belong to one of the species *Spirontocaris groenlandica* (= *Lebbeus groenlandicus*), *S. mardii* (= *Eualus gaimardii*) or *S. spinus*. The absence of abdominal spines of exopods on the peraeopods eliminates the larvae from both *E. gaimardii* (p. 194) and *S. spinus* (see p. 187), and their lack of exopods suggests close affir with *L. polaris*. The only members of the genus *Lebbeus* recorded from Greenla waters are *L. polaris, L. groenlandicus* and *L. microceros* (cf. Holthuis, 1947), *L. microceros* (Krøyer) was not recorded by Stephensen (1935) and appears to very rare. "Larva 1A" therefore seems likely to belong to *L. groenlandic* Stephensen (1916) and Frost (1936) both described young stages of *L. gro landicus*.

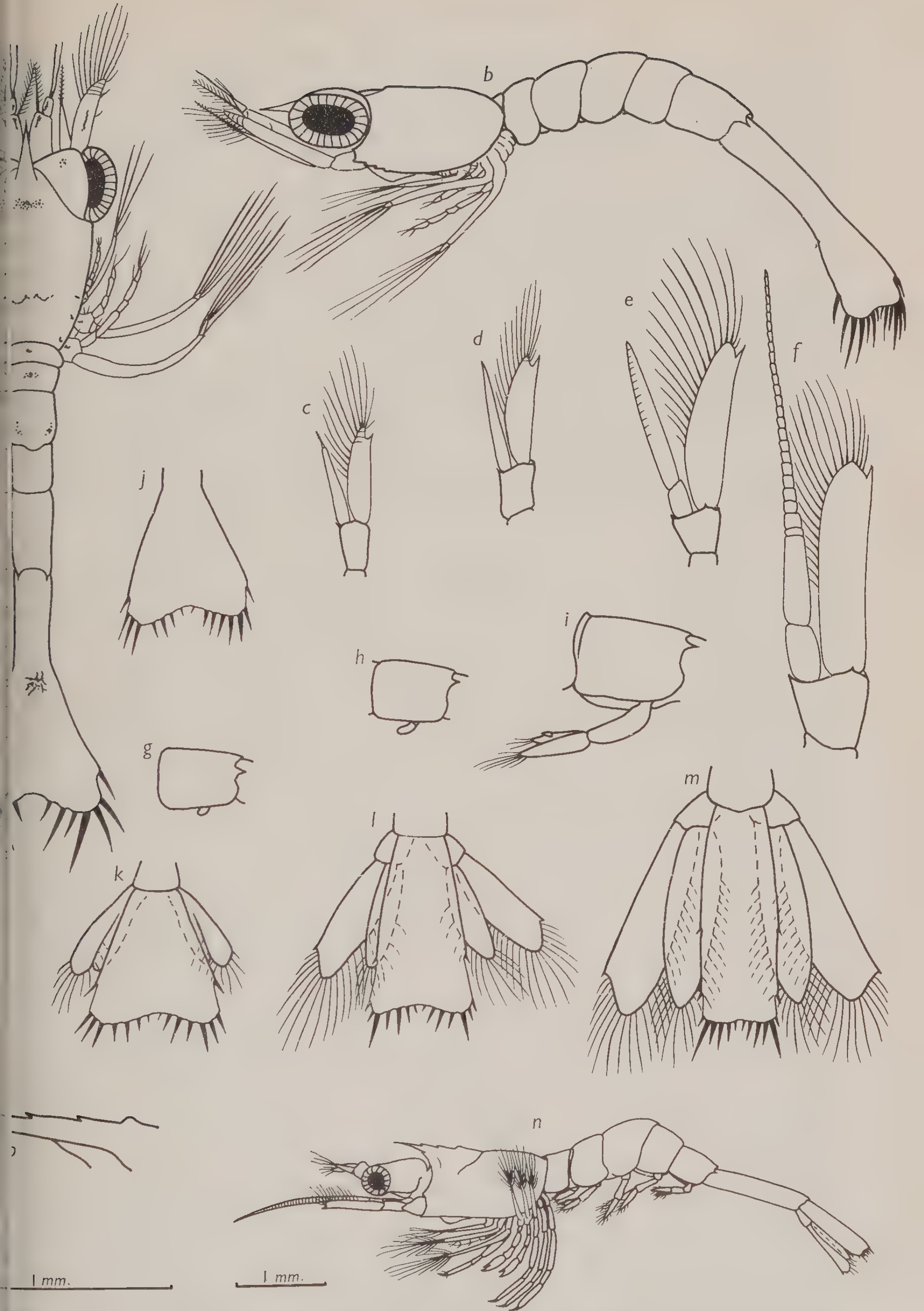
Eualus Thallwitz

Eualus gaimardii (H. Milne Edwards) (fig. 2)

? Stephensen, 1935: 54 (last zoeal stage only, as "*Spirontocaris*-larva No. 2A").
? Frost, 1936: 17, fig. 4 (as "*Spirontocaris* B").
Lebour, 1940: 505, fig. 1 (stage I only, as *Spirontocaris gaimardi*).
D. I. Williamson, 1957 b: 4, figs. 21-23 (figures after Lebour).

Lebour (1940) described stage I larvae supplied by Dr. A. G. Nicholls from laboratory hatching at Millport in April 1935. Further hatchings were obtained Millport in March 1953, March 1956 and March 1959, and some of the specime from the 1959 hatching were reared through all the zoeal stages to the megalo We have obtained only stages I and II from plankton.

Zoeal stages. Five zoeal stages were obtained. The rostrum is prominent a pointed in all stages and small supra-orbital spines are present from stage II. The



ig. 2. *Eualus gaimardii* (H. Milne Edwards). a, b, stage I. a, dorsal, showing chromatophores; b, ateral. c-f, antenna, ventral. c, stage II; d, stage III; e, stage IV; f, stage V. g-i, 5th abdominal mite and pleopod, lateral. g, stage III; h, stage IV; i, stage V. j-m, telson and uropods, dorsal. stage II; k, stage III; l, stage IV; m, stage V. n, stage V (= last zoeal stage), lateral. o, rostrum of stage VI (= megalopa), lateral. All at the higher magnification, except n.

is a dorsal tubercle on the anterior carapace and 3 or 4 denticles on the antero ventral margin behind each pterygostomian spine. The 5th abdominal somite bear a pair of small dorso-lateral spines, and an anal spine is present from stage I. Ther is no outer seta on the maxillule, and peraeopods 4 and 5 do not develop exopod

Chromatophores (fig. 2 a) with both yellow and red components occur on th front of each eye-stalk, on the anterior dorsal carapace and a variable number on th abdominal somites. Red chromatophores occur on the antennules, antennal scale mouth-parts, posterior dorsal carapace, at the bases of the maxillipeds and on th uropods. The number of chromatophores, particularly on the abdomen, tends t be greater in the later stages.

Stage I (fig. 2 a, b). Length about 2.9 mm. The rostrum reaches almost to th end of the antennular peduncle, and the antennule resembles that of *Spirontocari spinus*. There is a spine on the inner ventral side of the antennal peduncle, and th endopod ends in a long prickly spine with no accessory seta. The scale does no extend quite as far as the spine on the endopod and 4 segments are defined at it distal end. There is a slender outer spine at the base of the segmented portion, small seta is usually present about the middle of the outer margin and 10 seta arise from the inner and terminal margins. The exopods of maxillipeds 1-3 bea 4, 5, 5 setae respectively, and small uniramous rudiments of the first four pai of peraeopods are present. There are no abdominal appendages.

Stage II (fig. 2 c, j). Length about 3.4 mm. The terminal spine on the antenna endopod is shorter than in stage I. The scale is still segmented at the tip, the oute seta has been lost, the spine is stouter and the number of setae on the inner an terminal margins has increased to 12 or 13. The exopods of maxillipeds 1-3 bea 5, 7, 7 setae; the buds representing peraeopods 1-3 are biramous and those re presenting 4 and 5 are uniramous. A small inner pair of telson spines has bee added and the other spines are shorter than in stage I.

Stage III (fig. 2 d, g, k). Length about 3.8 mm. The rostrum reaches to abou the middle of the antennular peduncle in this and the remaining zoeal stages. Th antennal endopod is pointed but there is no longer a distinct apical spine. On segment is visible at the tip of the scale in most specimens and there are 13-16 seta on the scale. The exopods of the 1st pair of maxillipeds still each end in 5 setae those of the other two pairs each end in 9 setae, and those of the peraeopods ar still without setae. Small uniramous pleopod buds and unsegmented uropods ar present. The exopod of each uropod bears 9 or 10 setae and the endopod none The telson articulates with the 6th somite and is nearly 3 times as wide posteriorl as anteriorly.

Stage IV (fig. 2 e, h, l). Length about 4.6 mm. One segment is fully formed at the base of the antennal endopod and there are indications of several distal segments. There is a small ventral spine at the base of the scale and the scale bears about 17 setae. The exopods of the 1st maxillipeds still bear 5 setae each those of the 2nd and 3rd maxillipeds each bear 10 setae, and those of the 1st and 2nd peraeopods each bear 7 setae. The exopods of the 3rd pair are not setose.

he endopods of the 1st and 2nd peraeopods end in developing chelae. The leopod buds are biramous and unsegmented. Both branches of each uropod artic- late with the protopod, and the exopod bears 17, the endopod 9, setae. The lson is about twice as wide posteriorly as anteriorly and almost twice as long as s maximum width.

Stage V (fig. 2 f, i, m, n). Length about 5.4 mm. The only available specimen f this stage shows a combination of zoeal and megalopal characters which may e rare in nature. Features which by comparison with related species would be onsidered megalopal are the presence of 2 dorsal teeth on the rostrum, the ab- nce of antero-ventral carapace denticles, the long antennal flagellum of 27 seg- ents and the comparatively long setae on the uropods. On the other hand, the pra-orbital spines and the spines on the 5th abdominal somite are still present, e thoracic exopods are large and functional and the telson is still of the zoeal pe. The exopods of maxillipeds 1-3 bear 5, 10, 10 setae and those of peraeopods -3 bear 9, 9, 7 setae respectively. The telson is almost parallel sided and nearly times as long as wide.

MEGALOPA. A reared specimen which probably corresponds to the normal egalopa is about 5.4 mm long. The rostrum has 3 dorsal teeth and there are no pra-orbital spines or abdominal spines. The thoracic exopods are reduced and e no longer functional as swimming appendages, and the pleopods are fully tose. The telson is damaged.

REMARKS. The adult of *E. gaimardii* has no supra-orbital spines. Stephensen 1916: 255, 258) supposed that the larvae of such species would also lack supra- bital spines, but the present account shows that these spines are present from eal stage II (as in most caridean larvae) and are lost at the moult to the mega- pa.

"*Spirontocaris*-larva No. 2A" (Stephensen, 1935) and "*Spirontocaris* B" (Frost, 36) appear to be identical and probably belong to a variety of *E gaimardii*. oth Stephensen and Frost give the length of the last zoeal stage as 9 mm, hich is considerably larger than the specimen reared in the Millport Laboratory, t there is agreement on the number of exopods, the abdominal armature and e telson spines. The toothed rostrum and setose pleopods of the Millport specimen the last zoeal stage were not shown in Frost's illustration, but, as already men- oned, the Millport specimen is likely to be atypical in these respects. Adults of *gaimardii* are known to show a transition from forma *gaimardii* in the southern rt of their range through forma *gibba* (Krøyer) to forma *belcheri* (Bell) in e extreme north (Holthuis, 1947: 43), and Lebour (1936: 98) quotes Dr. horson as saying that specimens of *E. gaimardii* from east Greenland have fewer d larger eggs than those from Danish waters. The large larva recorded by Ste- ensen was from north-west Greenland, where most of the adult *E. gaimardii* ere of forma *gibba* (cf. Stephensen, 1935: 17), and Frost's specimens were from ewfoundland, where *E. gaimardii* forma *gibba* again occurs (Rathbun, 1929). seems likely that large eggs and larvae are features of the northern forms of

E. gaimardii, and that "*Spirontocaris*-larva No. 2A" (Stephensen, 1935) a
"*Spirontocaris* B" (Frost, 1936) were both larvae of *E. gaimardii* forma *gib*

Eualus pusiolus (Krøyer) (fig. 3)

? Frost, 1936: 17, fig. 5 (as "*Spirontocaris* C").
Bull, 1939: 43, fig. 1 (stage I only, as *Spirontocaris pusiola*).
D. I. Williamson, 1957 b: 4, figs. 27-30.

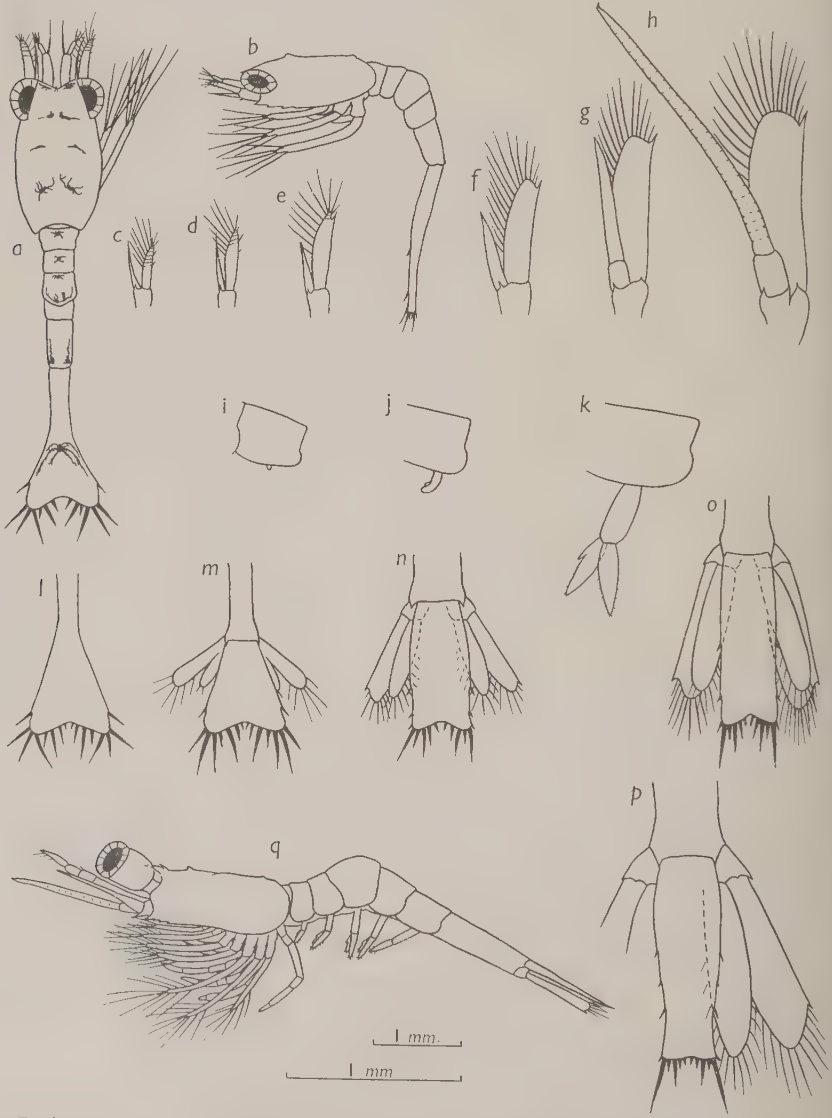


Fig. 3. *Eualus pusiolus* (Krøyer). a, b, stage I. a, dorsal, showing chromatophores; b, lateral. c antenna, ventral. c, stage I; d, stage II; e, stage III; f, stage IV; g, stage V; h, stage VI. i-k, abdominal somite and pleopod, lateral. i, stage IV; j, stage V; k, stage VI. l-p, telson and uropo dorsal. l, stage II; m, stage III; n, stage IV; o, stage V; p, stage VI. q, stage VI (= last zo stage), lateral. All at the higher magnification, except q.

Stage I larvae were obtained from a laboratory hatching at Millport in March
59, and the megalopa has been reared from the last zoeal stage on several
asions both at Millport and Port Erin. Larvae of this species occur in the
nkton of both the Irish Sea and the Firth of Clyde from February to August
September, and all zoeal stages have been taken from both areas.

ZOEAL STAGES. The great majority of the specimens examined could each be
ocated to one of the six zoeal stages described below, but specimens intermediate
ween stages V and VI have been found, and the large size-range of the last
al stage suggests that not all specimens pass through the same number of
ges. The number of stages may well be partly dependent on the diet, as in
cies of *Palaemonetes* (cf. Broad, 1957) and *Pandalus* (cf. Pike & Williamson,
published).

The rostrum is minute in stage I and very small in the other stages, and there
both an anterior and a posterior dorsal tubercle on the carapace. Three denticles
present on the antero-ventral margin of the carapace, behind each pterygostomian
ne. Apart from the anal spine, which is present from stage I, the abdominal
nites are completely unarmed. No exopod is developed on the last peraeopod.
Chromatophores (fig. 3a) with red and yellow components occur on the front
each eye-stalk, on either side of both the anterior and posterior dorsal tubercles
the carapace, usually on the sides of the thorax, medio-dorsally on the anterior
f of abdominal somites 1-3 and dorso-laterally on the posterior half of somites
nd 5. A large chromatophore branches from the anal region to cover the anterior
f of the telson, and a few additional chromatophores are sometimes present in
later zoeal stages.

Stage I (fig. 3 a-c). Length 2.2-2.6 mm. The peduncle of the antennule is
re slender than in either *E. gaimardii* or *Spirontocaris spinus*. There is a ventral
ne at the base of the antennal endopod, and this ramus ends in a single long
ckly spine which extends just beyond the tip of the scale. The distal half of
scale is segmented and up to 6 segments are defined. There are 2 small setae
the outer margin and 10 others round the terminal and inner margins of the
e. The exopods of maxillipeds 1-3 bear 4, 5, 5 setae respectively, and there
no traces of peraeopods or abdominal appendages.

Stage II (fig. 3 d, l). Length 2.6-3.0 mm. Compared with stage I, the terminal
ne on the antennal endopod is a little shorter, only 4 segments are visible at
tip of the scale, the distal outer seta on the scale is thicker and a small terminal
a is lost. The exopods of the maxillipeds bear 5, 8, 8 setae, there are small
amous buds representing the first two pairs of peraeopods and minute uniramous
ds representing the third pair.

Stage III (fig. 3 e, m). Length 3.3-3.8 mm. The antennal endopod now ends
a smooth point and it extends to about the middle of the scale. Only 2 segments
visible at the tip of the scale, the proximal outer seta has disappeared, the
al is replaced by a spine and there are 11 setae on the inner and terminal
rgins. Setose thoracic exopods are still confined to the maxillipeds, and there

are biramous rudiments of peraeopods 1-4 and small uniramous rudiments of the 5th pair. Unsegmented uropods are present; the endopod of each ends in 2 short setae and is ½ to ¾ the length of the exopod. There is no spine on the exopod The telson articulates with the 6th somite and is more than twice as wide posteriorly as anteriorly.

Stage IV (fig. 3 f, i, n). Length 4.0-4.5 mm. The antennal endopod is about 2/3 the length of the scale. The scale is not segmented and bears at least 15 setae. The exopods of legs 1 and 2 are setose, and there are small uniramous pleopod buds on somites 2-5. Both the exopod and endopod of each uropod articulate with the protopod; the outer margin of the exopod terminates in a spine and both rami bear many setae. The telson is almost parallel sided and is about twice as long as wide.

Stage V (fig. 3 g, j, o). Length 4.5-4.8 mm. The antennal endopod is about as long as the scale and has one segment formed at its base. There is a small ventral spine on the protopod at the base of the scale, in addition to that at the base of the endopod. The endopods of all the peraeopods are segmented, those of pairs 1 and 2 ending in small chelae, and the exopods of peraeopods 1-4 are setose There is a small uniramous pleopod bud on somite 1 and biramous pleopod buds are present on somites 2-5. The telson is parallel sided and 3 times as long as wide

Last zoeal stage (fig. 3 h, k, p, q). Length 4.5-6.6 mm. As stated above, thi is usually stage VI but in some cases it may be stage VII.

The antennal endopod is appreciably longer than the scale and in larger specimens it is nearly twice as long. The many segments of the next stage can be seen through its cuticle. The pleopods are jointed, a number of very short setae protrude from each ramus and an appendix interna is present on each endopod. The telson is widest at about ¼ its length and narrowest at about ¾ its length. It is about 3 times as long as its greatest width. An additional lateral telson spine, making a total of 9 + 9 marginal spines, is present in all the larger specimens.

MEGALOPA. The specimens obtained of this stage are all 4.7 or 4.8 mm long The rostrum is only slightly longer than in the last zoeal stage and is without either dorsal or ventral teeth. There are no supra-orbital spines or antero-ventral carapace denticles. The antennal flagellum is more than half as long as the body the carpus of the 2nd peraeopod is sub-divided into 5 or 6 segments and the exopods on peraeopods 1-4 are short and without setae.

REMARKS. "*Spirontocaris* C" (Frost, 1936) is almost certainly *E. pusiolu.* Frost illustrated the last zoeal stage, and, except that no denticles were shown on the antero-ventral carapace margin, it agrees very closely with the correspondin stage of *E. pusiolus* from British waters.

Eualus occultus (Lebour) (fig. 4)

Lebour, 1932: 131, pls. I-III (part) (as *Spirontocaris cranchii*).
Lebour, 1936: 96, pl. VI figs. 1-4, 6, 9, pl. VII fig. 3 (as *Spirontocaris occulta*).
D. I. Williamson, 1957 b: 4, figs. 24-26 (stage I only, partly after Lebour).
Bourdillon-Casanova, 1960: 45, fig. 11 (stage I only).

We have not obtained laboratory hatchings of this species, but it was hatched in the Plymouth Laboratory by Lebour (1936) who reared some of the hatched specimens to the 4th young stage and who also reared a planktonic larva to the 11th young stage. In an earlier paper, Lebour (1932) had attributed the later stages of this species to *Spirontocaris cranchii* (= *Thoralus cranchii*). The present account is based on planktonic specimens from the Irish Sea, where they occur from July to November with a maximum in September or October.

ZOEAL STAGES. The larvae are very similar to those of *E. pusiolus* but can be distinguished throughout the zoeal stages by the presence of a small dorsal tuft of setae on the 4th abdominal somite and a row of fine denticles on the dorsal posterior margin of the 5th somite. Another difference from *E. pusiolus* is that in British specimens the rostrum does not appear until stage II, although stage I specimens hatched at Marseilles by Bourdillon-Casanova (1960) each had a small rostrum. There are usually only 2 antero-ventral carapace denticles and there are more zoeal stages than in *E. pusiolus*. Nine planktonic stages were recorded off Plymouth (Lebour, 1936), off Marseilles (Bourdillon-Casanova, 1960) and in he Irish Sea (present work). The species resembles *E. pusiolus* rather than *E. gaimardii* in that there are exopods on peraeopods 1-4 in the later zoeal stages. A posterior dorsal tubercle on the carapace is often visible, but only an anterior one was seen in the specimens illustrated.

The coloration is similar to that of *E. pusiolus,* but there are additional chromatophores on the antennules, at the bases of the exopods of the maxillipeds and dorsally on the 3rd and 6th abdominal somites (fig. 4a).

Stage I (fig. 4 a-c). Length 2.0-2.2 mm. As already mentioned, British specimens lack a rostrum in this stage. The appendages resemble those of *E. pusiolus* in the same stage.

Stage II (fig. 4 d, q). Length 2.4-2.5 mm. A small rostrum is now present, the antenna resembles that of *E. pusiolus* in the same stage, and there are rudiments of peraeopods 1 and 2.

Stage III (fig. 4 e, r). Length 2.8-3.0 mm. The antenna is less developed than in *E. pusiolus* in stage III; the endopod still bears a prickly spine which reaches to about ¾ the length of the scale, and the scale still shows 4 terminal segments nd bears 2 outer setae. Peraeopods 1 and 2 are fairly large and biramous but are unsegmented and without setae, while peraeopods 3 and 4 are small buds and 5 is not represented. The uropods resemble those of *E. pusiolus*, but the telson is narrower, with its posterior width less than twice its anterior width.

Stage IV (fig. 4 f, s). Length 3.1-3.5 mm. The antennal endopod now ends in a smooth spine which extends to about the middle of the scale. The scale is no longer segmented, the proximal outer seta has been lost and the distal outer seta has been replaced by a spine. There is a small ventral spine at the base of the scale in addition to the rather larger one at the base of the endopod. The exopods of peraeopods 1 and 2 are setose, peraeopods 3 and 4 consist of biramous non-setose buds and peraeopod 5 is a small uniramous bud. Both rami of each uropod artic-

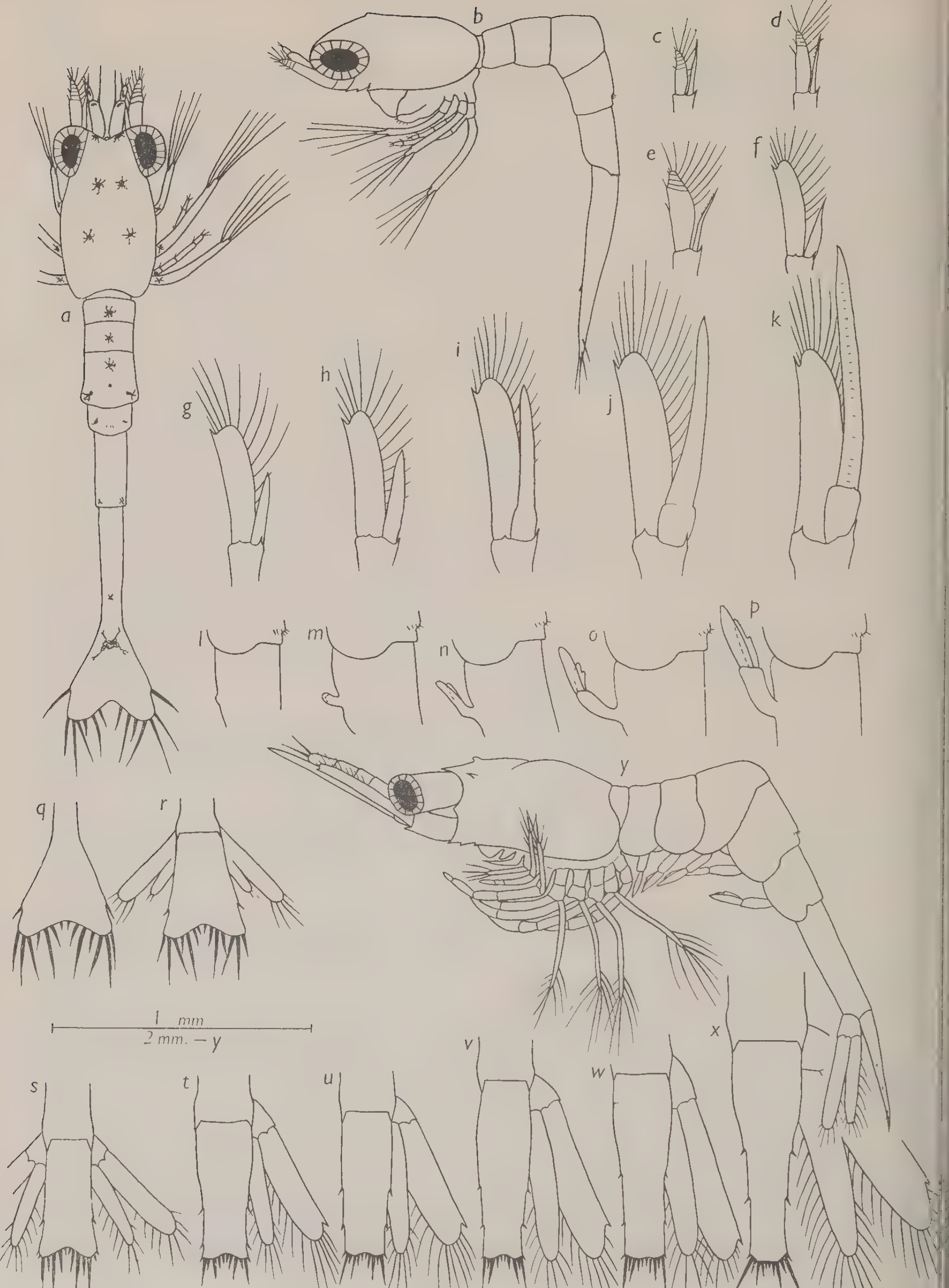


Fig. 4. *Eualus occultus* (Lebour). a, b, stage I. a, dorsal, showing chromatophores; b, lateral. c-k, antenna, ventral. c, stage I; d, stage II; e, stage III; f, stage IV; g, stage V; h, stage VI; i, stage VII; j, stage VIII; k, stage IX. l-p, 5th abdominal somite and pleopod, lateral. l, stage V; m, stage VI; n, stage VII; o, stage VIII; p, stage IX. q-x, telson and uropods, dorsal. q, stage II; r, stage III; s, stage IV; t, stage V; u, stage VI; v, stage VII; w, stage VIII; x, stage IX. y, stage IX (= last zoeal stage), lateral. Scale: 1 mm for all, except y where it is 2 mm.

late with the protopod, and the telson is slightly wider posteriorly than anteriorly nd about twice as long as its posterior width.

Stage V (fig. 4 g, l, t). Length 3.5-3.9 mm. The tip of the antennal endopod s pointed but without a distinct spine, and it reaches to about the middle of the cale. The exopod of peraeopod 3 is functional but that of peraeopod 4 still lacks etae and is held under the thorax. There are very small uniramous pleopod buds n somites 2-5. The telson is narrower posteriorly than anteriorly and its length s about 3 times its posterior width.

Stage VI (fig. 4 h, m, u). Length about 4.0 mm. The antennal endopod is a ittle more than half as long as the scale, the exopod of the 4th peraeopod is unctional and its endopod segmented, while the 5th peraeopod is still unsegmented. There are small uniramous pleopod buds on somite 1 and the buds on omites 2-5 are usually bilobed at the tip. The telson is slightly longer and narrower than previously and its length is about 3.5 times its posterior width.

Stage VII (fig. 4 i, n, v). Length 4.1-4.4 mm. The antennal endopod is almost s long as the scale, the last peraeopod is indistinctly segmented, and the pleopods re distinctly bilobed but not yet segmented. The length of the telson is more han 4 times its posterior width.

Stage VIII (fig. 4 j, o, w). Length 4.8-5.0 mm. The antennal endopod is onger than the scale and one segment is formed at its base. The pleopods are egmented and each shows a small appendix interna, and the telson is nearly 5 imes as long as its posterior width.

Stage IX (fig. 4 k, p, x, y). Length 5.1-5.4 mm. The antennal endopod is up o 1.5 times as long as the scale and shows traces of segmentation throughout its ength. The pleopods are large and usually show a number of short setae, and he telson is at least 6 times as long as its posterior width. In contrast to *E. pusiolus,* o specimens have been seen with an additional pair of telson spines.

Eualus fabricii (Krøyer)

Stephensen, 1916: 259, figs. 8-10 (as "*Spirontocaris* larva Nr. 3, *Sp. Fabricii?*").
Stephensen, 1935: 55 (as "*Spirontocaris*-larva No. 3, ? *Spiront. fabricii* (Krøyer)").
Frost, 1936: 15, fig. 2 (as *Spirontocaris fabricii*).

Stephensen's "*Spirontocaris* larva Nr. 3" was the most abundant of the spirontocarid larvae in his Greenland material and he attributed it to the same species s the most abundant adult, namely *S. fabricii* (= *Eualus fabricii*). Larvae agreeing vith those described by Stephensen were also the most abundant in the material rom Newfoundland examined by Frost (1936). Stephensen (1916) described nd figured stage III (as "youngest stage"), stage IV (as "intermediate stage") nd stage V or VI (as "oldest stage"), and Frost (1936) figured the last zoeal tage (probably stage VI or VII). The size-range of these stages is from 5 to 10 nm. The larvae are appreciably bigger than those of *E. pusiolus,* the rostrum is onger and there is a well developed antennal spine on the anterior margin of the arapace in the late zoeal stages, but they resemble *E. pusiolus* larvae in their lack of abdominal armature and in the presence of exopods on peraeopods 1-4.

Eualus herdmani (Walker)

Needler, 1933: 241 (stage I only, as *Spirontocaris herdmani*).

From the description given by Needler (1933), the only distinction that ca be made between the stage I zoea of *E. herdmani* and that of *E. pusiolus* is th absence of a rostrum in the former. No later stages are described.

Heptacarpus Holmes

Heptacarpus paludicola (Holmes)

Needler, 1933: 239, fig. 1 A-J (stage I only, as *Spirontocaris paludicola*).

Heptacarpus tridens (Rathbun)

Needler, 1933: 239, fig. 1 L (stage I only, as *Spirontocaris tridens*).

Heptacarpus brevirostris (Dana)

Needler, 1933: 241 (stage I only, as *Spirontocaris brevirostris*).

Our knowledge of the larvae of *Heptacarpus* is restricted to these three speci and to the first zoeal stage of each. None of the species has a rostrum in stag I or any abdominal armature apart from an anal spine. *H. paludicola* has 2 anter ventral carapace denticles on each side, but the carapace margins are smooth in th other two species. The antennal scale is segmented at the tip in *H. paludicola* an *H. brevirostris* but not in *H. tridens*. There are no peraeopods or abdominal ap pendages in any of the species in stage I. The lengths of the larvae are: *H. palu dicola*, 2.0 mm; *H. tridens*, 3.0 mm; *H. brevirostris*, 1.5 mm.

Thoralus Holthuis

Thoralus cranchii (Leach)

H. C. Williamson, 1915: 375, figs. 75-80 (stage I only, as *Hippolyte cranchii*).
Lebour, 1932: 131, Pls. I-III (part) (as *Spirontocaris cranchii*).
Lebour, 1936: 93, Pl. VI figs. 5, 8 (as *Spirontocaris cranchii*).
D. I. Williamson, 1957 b: 4, figs. 31-33 (stage I only, after H. C. Williamson).
Bourdillon-Casanova, 1960: 46, fig. 12 b (stage I only, as "*Thoralus cranchi*, spécimen de la Manche after Lebour).

Stage I larvae of *Thoralus cranchii* from laboratory hatchings were describe by H. C. Williamson (1915) and Lebour (1932), while Lebour (1936) describe nine zoeal stages from the Plymouth plankton and also the megalopa and 1s young stage reared from the last zoeal stage. One of Lebour's specimens, capture in the last zoeal stage, was reared to the 1st young stage. Lebour (1936) showe that the later zoeal stages which she had attributed to this species in 1932 wer actually larvae of *Eualus occultus*. We have not obtained laboratory hatchings o *T. cranchii*, and only small numbers of larvae of this species have been taken i the Irish Sea and the Firth of Clyde.

The larvae resemble those of *E. occultus,* but they are slightly smaller, a pair f lateral spines (but no denticles) is present on the 5th abdominal somite and ere are usually a few small dorsal setae on the 4th somite. Peraeopods 4 and 5 oth lack exopods in all stages, and the chromatophore pattern differs from that f *E. occultus* in the presence of two chromatophores on each of abdominal so- ites 1 and 2 and one on each of the posterior lobes of the telson in the early ages.

Thoralus sp.

ourdillon-Casanova, 1960: 46, fig. 12 a (stage I only, as "*Thoralus cranchi,* spécimen de Marseille").

Adult specimens of "*Thoralus cranchii*" from the Mediterranean are of two rms, separable according to the length of the rostrum (Zariquiey Alvarez in ourdillon-Casanova, 1960). Bourdillon-Casanova (1960) obtained a laboratory tching from the form with the short rostrum, and the resulting larvae differed om typical larvae of *T. cranchii* in having a small rostrum in stage I and dorsal enticles in addition to lateral spines on the posterior margin of the 5th abdominal mite. The chromatophore pattern was very similar to that of *E. occultus.* Larvae both this and of the typical form were very common in the plankton off Mar- illes. The evidence appears to favour the recognition of a second species of *horalus.*

DISCUSSION

Holthuis (1947) subdivided the large genus *Spirontocaris,* as used by such thors as Calman, Rathbun, Stephensen and Lebour, into *Spirontocaris* s.s., *Leb- eus, Birulia, Eualus, Heptacarpus* and *Thoralus.* No larvae of *Birulia* are de- ribed, but, as the present paper shows, larvae are known for representatives of ch of the other five smaller genera. Not all the descriptions are equally detailed, d in the case of *Heptacarpus* they are restricted to the first zoeal stage, but it ems probable that the following characters apply to all the larvae of *Spirontocaris* l.: (1) There is a general similarity of body form in all species. (2) The rostrum es not develop dorsal or ventral teeth in the zoeal stages. (3) An anal spine is esent from stage I. (4) The eye-stalks are approximately cylindrical and never eatly elongated. (5) The antennular peduncles are almost straight and not widely parated. (6) There is no outer seta on the maxillule. (7) None of the peraeo- ds is abnormally elongated or expanded or develops precociously.

No other larvae are known with this combination of characters, and the de- ribed larvae therefore appear to confirm *Spirontocaris* s.l. as a natural phylo- netic unit.

While supporting the recognition of this unit, larval characters suggest that it ould be accorded supra-generic, rather than generic, status, for it includes a eater degree of larval variation than any known single genus of the Caridea. We ay disregard, in this connection, such characters as the number of antero-ventral carapace denticles and the abdominal armature, which are normally of only specific importance. The number of zoeal stages is also frequently of specific importance or may even vary within a species (see p. 199), but the extreme range of from 2 (or 3) to 9 zoeal stages shown by the present group of species is unequalled in any known genus. The state of development at hatching shows little variation within accepted genera, but the spirontocarid group includes stage I larvae in which all appendages except uropods are present and segmented and others with no trace of appendages posterior to the maxillipeds. The size of the zoeal rostrum is frequently of generic importance but it shows a considerable range within the spirontocarid group. Finally, the number of peraeopods bearing exopods in the late zoeal stages is constant throughout the known larvae of nearly all accepted genera, but in the present group it varies and may be 0, 2, 3 or 4.

The distribution of these "generic" characters in the known larvae of the smaller genera recognised by Holthuis (1947) is shown in the following table:

	Lebbeus	*Spirontocaris*	*Eualus*	*Heptacarpus*	*Thoralus*
No. of zoeal stages	?2	5	5-9	?	9
No. of peraeopods in stage I (unsegmented rudiments in brackets)	5	(5)	0-(4)	0	0
Rostrum in stage I	small	large	large, minute or absent	absent	minute or absent
No. of peraeopods with exopods in last zoeal stage	0	2	3 or 4	?	3

It must be stressed that larvae are known for only a very few species of each genus, and confirmation from further species is very desirable. On this limited evidence, however, the known larvae of *Lebbeus* and of *Spirontocaris* s.s. appear to form a clear generic group in each case. In the case of *Eualus*, on the other hand, there is a considerable range of larval characters, but the known species form two distinct groups:

(1) *E. gaimardii*, in which there are 5 zoeal stages, stage I has a large rostrum and rudiments of 4 pairs of peraeopods, and in the late zoeal stages exopods are present on peraeopods 1-3;

(2) *E. pusiolus, E. occultus, E. fabricii* and *E. herdmani*, in which there are (probably) 6-9 zoeal stages, in stage I the rostrum is minute or absent and there are no peraeopod rudiments, and in the late zoeal stages exopods are present on peraeopods 1-4. (In the case of *E. fabricii* and *E. herdmani* the evidence is incomplete).

Larval characters appear to suggest a generic distinction between these two groups, but as we have not succeeded in finding any adult character by which they may be separated it would not seem justified to propose a new genus. Recognition of these two groups is, however, necessary to separate the larvae of *Eualus* from those of *Thoralus*. Larvae of *E. gaimardii* (group 1) differ from those of *horalus* in the number of zoeal stages, the state of development at hatching and e length of the rostrum, while the other known larvae of *Eualus* (group 2) iffer from those of both *E. gaimardii* and *Thoralus* in the number of exopods resent in the later zoeal stages.

The very limited information available on the larvae of *Heptacarpus* does not ermit any distinction to be made between them and the larvae of either *Eualus* roup 2 or *Thoralus*. Larval evidence, when available, may well be decisive in etermining the rival claims to recognition of *Heptacarpus* Holmes and *Spiron-ocarella* Brashnikov (see Holthuis, 1947: 36), but this would require descriptions f both early and late stages of several more species.

In spite of the slight divergence over *Eualus*, there is good general agreement etween the adult and larval classifications of the spirontocarid group of species. his seems to confirm that both systems have a sound phylogenetic basis, and it mplies that adult and larval evolution within the group have proceeded along lmost parallel lines.

ZUSAMMENFASSUNG

Diese Veröffentlichung behandelt die Larven von *Spirontocaris* s.l. (einschliesslich *Lebbeus, Eualus, eptacarpus* und *Thoralus*). Die Larven-Stadien von *S. spinus, S. lilljeborgii, E. gaimardii, E. pusio- s* und *E. occultus* werden beschrieben und die veröffentlichten Beschreibungen anderer Larven der ruppe kritisch besprochen. Die an den Larven gewonnenen Erkenntnisse sprechen sehr zugunsten ner Unterteilung von *Spirontocaris* s.l. und dafür, dass *Spirontocaris* s. str., *Lebbeus* und *Thoralus* s Gattungen anzusehen sind. *Eualus* enthält Larven von zwei verschiedenen Gruppen. Die Kenntnis er Larven von *Heptacarpus* ist auf Stadium I beschränkt und unzureichend, um eine Trennung von *ualus*- und *Thoralus*-Larven zu ermöglichen.

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A NEW CIRRIPED FROM THE HAWAIIAN ISLANDS

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During the summer of 1960 the writer had the opportunity of examining the irripedia in the collections of The American Museum of Natural History while eparing a paper on the Balanomorpha which were collected during the Puritan-merican Museum of Natural History Expedition to western Mexico. The present per describes a heretofore unknown subspecies of the genus *Tetraclita* which believed to occur intertidally in the Hawaiian Islands. The specimens, all of hich were living on an angular cobble, were preserved dry, thus the cirri and outh parts could not be examined.

The writer would like to express his appreciation to Drs. William K. Emerson, orothy E. Bliss and Meredith L. Jones, The American Museum of Natural istory, all of whom have generously offered advice and guidance during the urse of this, and previous studies.

Balanidae Gray, 1825

Tetraclitinae Nilsson-Cantell, 1921

Tetraclita Schumacher, 1817

Subgenus **Tetraclitella** Hiro, 1939

Definition. Shell small, depressed, and usually of a light color; compartments ur, usually separate; parietes porose, 2 or more rows in mature forms; radii oad, with horizontal summits, permeated radially by pores; basis calcareous or embranous; scutum usually transversely elongated with an external median lcus, lacking crests for the depressor muscles; tergum not elongated, with short oad spur; mandible with 5 teeth, a few spinules, and a spine-like lower extremity; axilla I with 6 to 7 spines below the upper notch.

Distribution and habitat. Recent: New Zealand, Australia, Madagascar, va, Philippine Islands, China, Taiwan (Formosa), Pescadores Islands, southern pan, Marshall Islands and Hawaiian Islands. *Tetraclitella* usually occurs under cks or shells low in the intertidal zone or subtidally.

Type species. *Tetraclita purpurascens* (Wood, 1815) [= *Lepas purpurascens* ood, 1815], by original designation (Hiro, 1939: 273).

Tetraclita (Tetraclitella) divisa subquadrata new subspecies (pl. IV figs 1-5)

Diagnosis. This new subspecies is characterized by the almost square basal outline of the shell, and by the internal roughening of both opercular valves.

Description. The shell is greatly depressed, nearly quadrate in basal outline and covered with a dark brown chitinous membrane. The four compartments are furnished with radial ribs, usually three to a compartment in juveniles, and imbricating growth ridges bearing fine chitinous bristles. Mature specimens do not show any constancy in the number of radial ribs, and in addition the ribs on the carina tend to be more obscure than those on the other compartments. The apically situated orifice is nearly diamond-shaped, the two sides nearest the carina being shorter than those nearest the rostrum. The parietes are permeated by three to six rows of pores which are usually hexagonal in transverse section. The radii are broad, not sunken below the surface of the parietes, and have horizontal summits; internally, large tubes similar to those of the parietes run transversely in one or two rows. The surfaces of the radii are sculptured with horizontal ridges and vertical striae, producing a cancellated appearance. There is a tendency, however, toward the obliteration of the horizontal ridges in some of the larger specimens, and the cancellated appearance may grade into simple vertical ribbing. The alae are triangular, very thin, and non-porose. The sheath, which occupies approximately the upper one-third of the shell, and the inner lamina are translucent. The basi is flat, extremely thin, and calcareous throughout.

The scutum is transversely elongated, the tergal margin being slightly more than one-half the length of the basal margin. Both of the basal angles are hollowed out. The exterior exhibits conspicuous, high, closely spaced growth ridges and a moderately deep median sulcus. Internally, the upper one-half of the valve is coarsely roughened. The articular ridge is high, reflexed, and is evenly rounded basally. The adductor ridge is very low, thick and short. It is situated almost on, and parallel to, the basal margin in much the same manner as in *Tetraclita purpurascens* (Wood). The sub-centrally situated adductor muscle depression is poorly delimited. From five to eight strong, oblique, teeth project along the occludent margin. There are no crests for the insertion of rostral or lateral depressor muscles.

The triangular tergum is sculptured in the same manner as the scutum. There is no apical beak. The broad, external, longitudinal furrow extends the length of the valve, and it is open throughout its length. The spur is short, obliquely rounded, and it is separated from the basi-scutal angle by less than its own width. The spur and carinad portion of the basal margin form an oblique angle. The articular ridge is high, reflexed, and it extends to the basal margin of the valve. There are from four to eight crests for the insertion of the tergal depressor muscles. The crests extend from the basal margin for one-third or less the length of the valve.

Remarks. Juvenile specimens of this new subspecies superficially appear to be conspecific with *Tetraclita costata* Darwin. The shell is almost the same shape, and it bears the exact same number of radial ribs (10). The fact that Pilsbry (1928) reported *T. costata* from the Hawaiian Islands poses some problems mainly because his description is inadequate, there are no accompanying illustrations, and his specimens lack opercular valves. The presence of an almost complete growth series of this new subspecies leads the author to believe that the specimens which Pilsbry referred to *T. costata* are actually this new subspecies. However, an examination of Pilsbry's specimens must be undertaken before this can be verified.

Tetraclita divisa subquadrata n. subsp. differs from the nominate subspecies mainly by the almost square rather than circular basal outline of the shell, by the variable number of radial ribs, and by the roughened internal surface of both opercular valves. In his description of the scutum of *T. divisa divisa* Nilsson-Cantell (1921: 363) states “Innenseite glatt, ohne Adductorkiel und Cristae.” Hiro (1939), however, remarks that specimens of this species have an adductor ridge, but it is often obsolete. In all of the specimens of this new subspecies which were examined, the adductor ridge, although at times poorly developed, was present. Also significant is the presence of an adductor muscle depression which neither Hiro nor Nilsson-Cantell mention or illustrate.

Nilsson-Cantell (1921) noted that in *Tetraclita divisa divisa* there is an abbreviated life-history, i.e., retention of the nauplii in the mantle cavity until the cypris stage has been reached. Usually 20 to 30 metanauplii or cypris larvae may be found in the mantle cavity of this species (Hiro, 1939). An examination of the living chamber of *T. divisa subquadrata* revealed no cyprids, but one specimen still possessed ova (25). They are relatively large, and of a bright orange color. The color suggests that they have been fertilized and might have reached the cypris stage within approximately two months.

Disposition of types. The holotype and 62 paratypes are in the collections of the Department of Living Invertebrates of The American Museum of Natural History, A. M. N. H. Nos. 11869 and 11870, respectively. All of the type specimens were collected by Addison E. Verrill, probably during the early part of 1925.

Measurements of holotype. Rostro-carinal diameter 8.6 mm, lateral shell diameter 8.6 mm, height of shell 1.4 mm, length of left scutum 1.6 mm, length of left tergum 1.3 mm.

Type locality and habitat. The accession card (No. 6152) for these specimens reads “Collection of marine invertebrates from Hawaiian Islands.” A thorough search was made for additional data relating to these specimens, but none could be found.

Although there is no ecological data available at this time, it may be inferred from the presence of an uneroded cuticle that this new subspecies occupies a sheltered habitat. The literature suggests that the species included in this subgenus show a strong preference for the undersurface of rocks or shells sheltered from the buffets of the surf (Hiro, 1939; Pope, 1945). The literature further suggests that the species of *Tetraclitella* usually occur low in the intertidal zone or even subtidally.

ETYMOLOGY. Latin, *subquadrata,* somewhat less than square, in reference to th basal outline of the shell.

RÉSUMÉ

Description d'une nouvelle sous-espèce, *subquadrata,* de *Tetraclita* (*Tetraclitella*) *divisa* Nilssor Cantell, fondée sur des exemplaires provenant du littoral des Iles Hawaii.

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ON THE MANDIBLE OF *PARANASPIDES LACUSTRIS* SMITH — A CORRECTION

BY

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INTRODUCTION

When Geoffrey Smith visited Tasmania in 1907-08, he found that *Paranaspides* was very abundant wherever there was a rich growth of weeds in the Great Lake, situated on Mt. Wellington at an altitude of 3,700 feet. But by 1929 conditions had apparently changed after the building of a dam and the consequent deepening of the lake. *Paranaspides* seemed to be on the verge of extinction and repeated efforts to collect material secured one adult and several immature specimens (Manton, 1930: 791). However, I wrote to the University of Tasmania to find out the present position and received the following reply from emeritus Professor V. V. Hickman (30 May 1960): "The change in water level of the Great Lake due to the construction of the dam in 1922 has not resulted in the extermination of the syncarid. Dr. J. W. Evans gave me a number of specimens which he collected in 1939, and within the last two years further specimens have been taken from the lake by Dr. A. G. Nicholls of the Fisheries Division of C.S.I.R.O.".

In his preliminary description of *Paranaspides lacustris* Smith did not say how many specimens he had collected, but he gives the length of the largest one as about 1 inch or 25 mm. In his later, more detailed work he again stated that the adult animal may attain an inch in length; therefore his coloured illustration of *Paranaspides* (which measures 45 mm) has been magnified about twice although the legend says that it is natural size (Smith, 1909: 562 and pl. II fig. 2). Smith's earlier figure of the animal in lateral aspect measures 86 mm giving an actual length of 21.5 mm for the magnification stated (Smith, 1908, pl. 13 fig. 2).

The most puzzling thing about Smith's description of *Paranaspides* concerns the mandible, which he figured once only, using the same figure in both papers (Smith, 1908, fig. 5 and 1909a, fig. 10). In the earlier paper (p. 470) Smith wrote: "Besides these differences distinguishing it from Anaspides, important differences exist in the structure of the mandible, which bears a four-jointed and distinctly biramous palp (Fig. 5), a characteristic only found elsewhere in Crustacea among the Copepoda...". Later he elaborated this as follows: "the [mandibular] palp has a peculiar formation, which is particularly marked in old specimens. In old specimens it appears to be distinctly four-jointed, and the basal joint carries a very definite, little, external branch tipped with two setae. In young specimens the extra joint, i.e. between segment two and three, may be absent and the external branch is not so conspicuous. The external branch occupies the position of an exopodite, and if the mandibular palp in this form is really biramous, it would be unparalleled in Crustacea, except among the Copepoda and Ostracoda. Considering, however, that *Paranaspides* is otherwise a rather specialised form, and that the character in question is best marked in old specimens, it seems doubtful if we are really dealing with a primitive characteristic" (Smith, 1909a: 506). This quotation shows that Smith had some doubts about the biramous nature of the mandibular palp. But Hansen (1925: 99) adopted the idea with enthusiasm: "I cannot see the slightest reason for supposing that the palp is not 'really biramous', ... as far as I know, there is also something in the doctrine of evolution which with good reason is named atavism". Hansen then went on to elaborate his views on the morphological value of the three segments in the mandibular palp of Malacostraca, based largely on a comparison of Smith's figure of the mandible of *Paranaspides* with the mandible of certain Copepoda.

Hansen's views on Crustacean mandibles have been accepted, or questioned (see e.g. Gurney, 1942: 128-131), or merely mentioned, by various subsequent authors. And on one such occasion Calman (1951) — reviewing a work in which Hansen's views were mentioned — commented as follows: "A good deal of importance is attached to Geoffrey Smith's supposed discovery of a vestigial exopod on the mandible of *Paranaspides* ...... It is necessary, therefore, to say that no one has been able to confirm Smith's statement on this point and that the 'exopod was certainly absent in the single specimen dissected by the present writer in order to search for it." Recently I had occasion to read a manuscript in which reference was made to the mandible of *Paranaspides* and this reminded me of the review just quoted. So I looked once again at the familiar figure (reproduced in Chappuis 1927, fig. 583 and in Siewing, 1959, fig. 8 A) and was immediately struck by something abnormal about the mandible chosen by Smith for illustration. A simple explanation of this biramous structure occurred to me — see below, p. 219 — but, before I could judge whether or not my interpretation was a probable one it was necessary to examine the mandible in actual specimens, preferably large ones. The British Museum had only four immature specimens presented by Smith and some enquiries revealed that material in other collections in this country was scanty. However, I have succeeded in examining the following material, ranging in size from 10 to about 23 mm in length of body.

MATERIAL EXAMINED

SYNTYPES: (i). Four immature specimens, 3 females and 1 male, measuring 10-12 mm in length, presented by G. Smith to the British Museum (Reg. no. 1908. xii. 21. 1-4). In a separate small tube are two mandibles and the paragnatha belonging to one of the syntypes — doubtless that dissected by the late Dr. W. T.

Calman. Adhering to the cotton wool stopper of the larger tube containing the specimens was another detached mandible.

(ii). Cambridge University Museum of Zoology possesses three syntypes presented by G. Smith (Reg. June 11, 1909); these were sent on loan by Dr. G. B. Goodhart and prove to be immature females, the largest measuring about 13.5 mm.

(iii). Oxford University Museum, Department of Comparative Anatomy: a tube containing about thirty specimens all syntypes collected by G. Smith (Ref. No. 5403, 1907-8). None of the complete specimens exceeds 13 mm in length and, although nearly all can be sexed, all are more or less immature. A fragment comprising the anterior head region with eyes, antennules, antennae and labrum belongs to a fully adult specimen that Smith must have dissected; but the rest of the specimen seems to have been lost. Dr. A. J. Cain brought these specimens to the British Museum for study some time after the manuscript had been prepared. A few of the smaller specimens have, on the anterior margin of the labrum, a slender, forwardly-directed spine (as in some Mysids). As a rule, there is only a slight boss or hump on this part of the labrum.

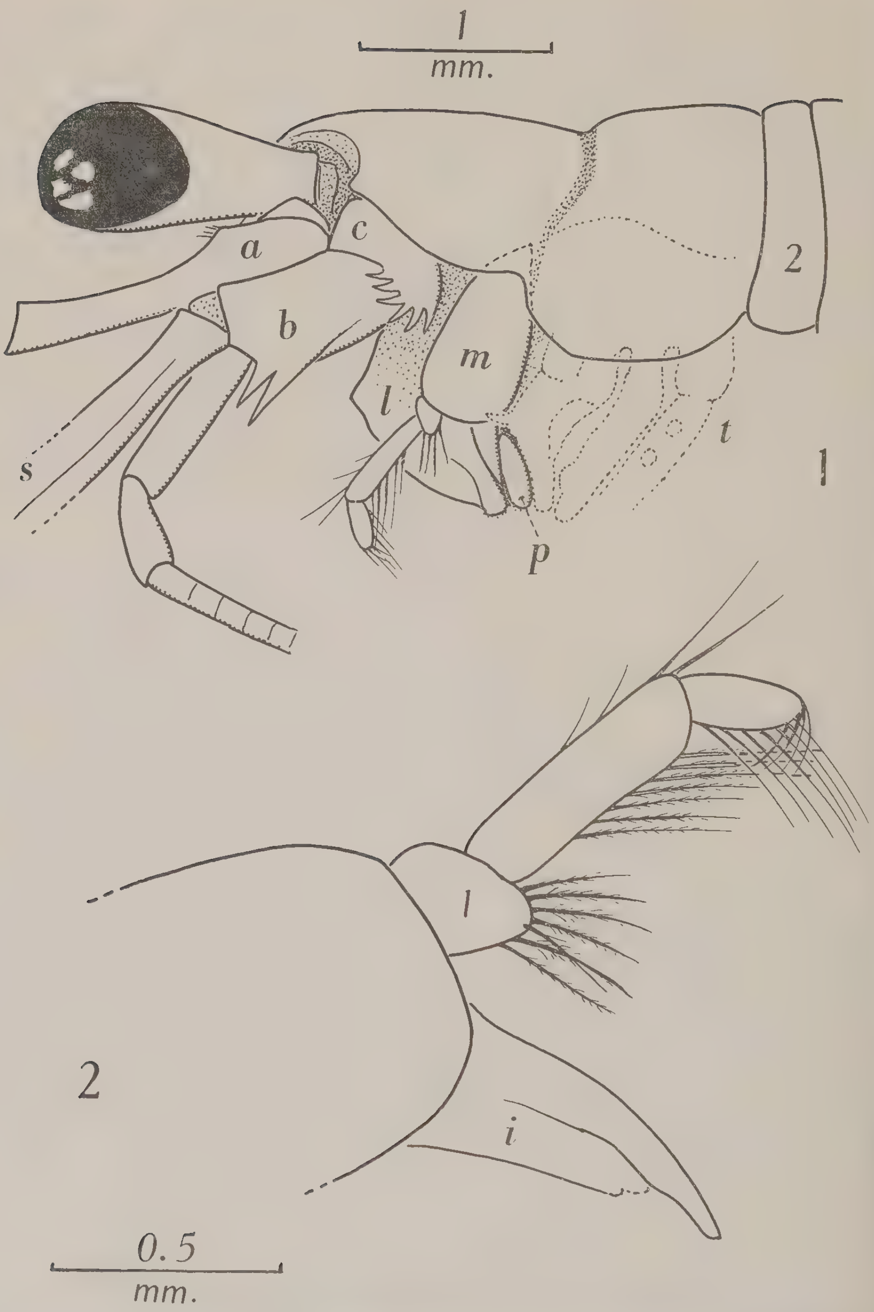
OTHER MATERIAL: *a.* Since Smith attached so much importance to old specimens (see above, p. 213), I asked Dr. S. M. Manton, F.R.S., if I might examine her adult specimen, a female of about 23 mm in length. (The body of *Paranaspides* has a slight median hump and in preserved specimens may not be quite straight, so I have measured in a straight line from rostrum to tip of telson). Dr. Manton has kindly presented this specimen to the British Museum, together with a micro-preparation of the head region of a smaller specimen in sagittal section — similar to that figured by Cannon and Manton, 1929: 178, fig. 2a. These are registered as 1960.v.6. 1-2.

b. Professor P. B. Medawar, F.R.S. of University College, London, has also presented to the British Museum the only two specimens of *Paranaspides* in his teaching collection, females of 17 and 18 mm in length (Reg. no. 1960.v.6. 3-4). These seem to be sexually mature, although the thelyca are not quite so well developed as in Dr. Manton's specimen.

c. Professor Hickman has sent me 4 males and 7 females (one broken), part of the material collected from trout stomachs in 1939 by Dr. Evans. These measure from 18 to 21 mm in length, are rather soft and, unfortunately, most of the epipodites and many of the appendages became detached in transit (Reg. no. 1960.vi.10. 1-8).

OBSERVATIONS ON THE MANDIBLE

The mandible in *Paranaspides* is almost fully exposed in lateral aspect and is thus fairly easy to examine in situ. In fairness to Smith, however, it is not easy to see clearly the details of the proximal part of the palp, and especially the setae, unless the proboscis-like labrum is moved away from the mouth so that the setae can be seen against the light. The head region of one of the University College specimens is represented in lateral aspect in fig. 1, but the maxillula,



Paranaspides lacustris Smith. Fig. 1. Head region, in lateral aspect, of a female measuring 15 mm in length. — Fig. 2. Distal part of mandible of the largest specimen collected by Dr. Manton, in situ. — a, antennular peduncle; b, basis of antenna; c, coxa of antenna; i, incisor process; l, labrum or upper lip; m, mandible; p, paragnath (lower lip); s, scale of antenna; t, first thoracic limb; 1, first segment of mandibular palp; 2, second thoracic somite.

maxilla and proximal portion of the first thoracic appendage are indicated diagrammatically by dotted lines. For a better illustration of these appendages in situ the reader is referred to Cannon and Manton, 1929, fig. 2c.

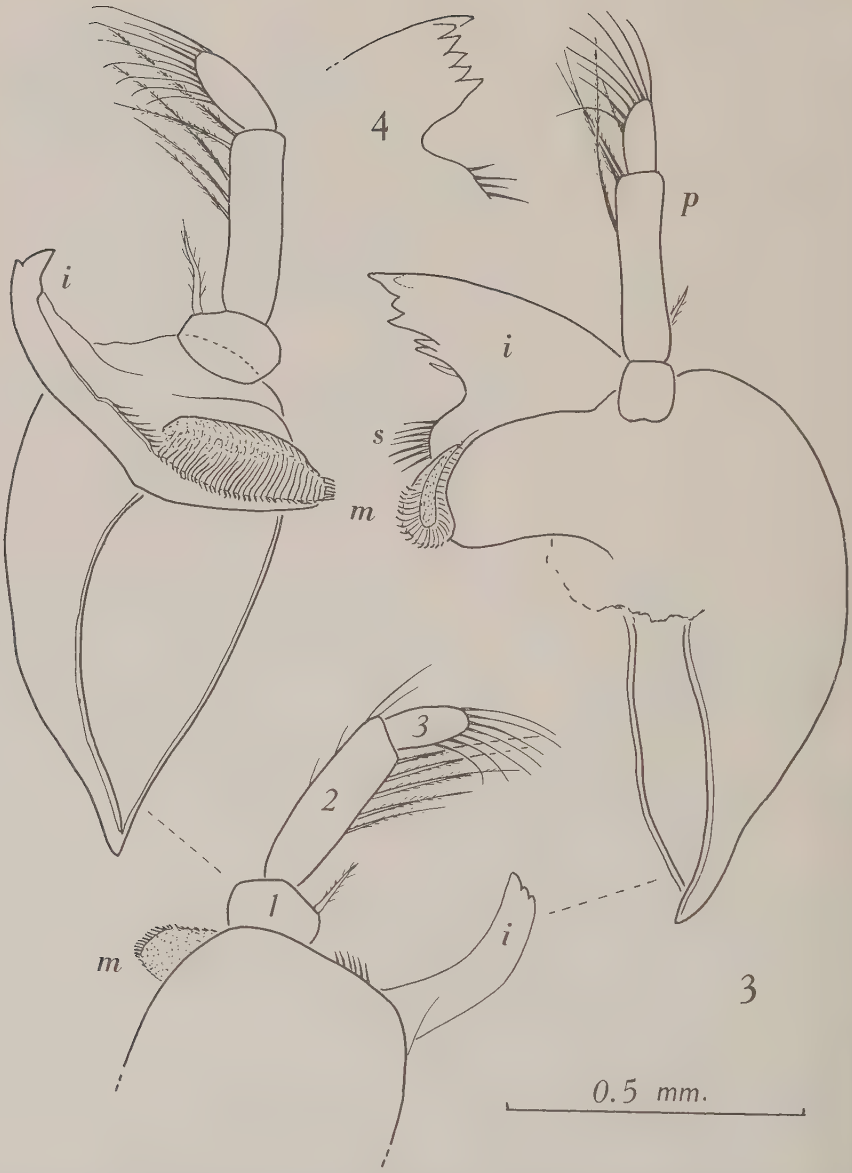
As I had anticipated, the mandibular palp proved to be quite normal, with three segments, in every specimen that I have examined irrespective of size. And Professor Hickman wrote that he agreed with my findings (30. v. 60).

Part of the right mandible of Dr. Manton's adult female is represented in lateral aspect in fig. 2; it was drawn in situ and therefore the incisor process is not clearly visible. A mandible removed from the largest syntype in the Cambridge Museum collection is represented in three different aspects in fig. 3. The short first segment of the palp is much wider than the second segment in certain aspects, though not in that nearest to the position figured by Smith (fig. 3, right hand sketch of the entire mandible). The setae on the postero-distal lobe (or the inner margin) of this basal segment vary in number from one to six or more as figs. 1 to 5 show; in this syntype there is only one rather stout seta although two is more usual in immature specimens. The form and armature of the incisor process seem to vary with age — cf. figs 3 and 4 from syntypes measuring 13 and 10 mm respectively. Fig. 5 represents part of the mandible from one of the 1939 specimens measuring about 19 mm.

I asked Dr. L. B. Holthuis of Leiden, at that time working in the U. S. National Museum, to examine any specimens in the collection at Washington. There are in the U. S. National Museum six specimens, measuring from 14 to 20 mm in total length, collected by W. M. Tattersall in 1914 (Reg. no. Crustacea 60112). Dr. Holthuis writes (2.v.60): "All specimens have been examined by me and also Dr. Chace has looked at the largest. In all of them the mandibular palp proved to be normal, i.e. three-segmented without any branching, thus fully confirming your own observations. It will certainly be worth while to have Smith's erroneous statement corrected".

DISCUSSION. Smith's statement that the mandibular palp is biramous in old specimens is certainly not in agreement with what is known of the development of the mandible in Crustacea. Calman (1909: 12) summarised the position in his introductory chapter thus: "The mandibles, like the antennae, are, in the nauplius, biramous swimming limbs with a masticatory gnathobase arising from the basal segment of the protopodite. This form and function are retained with little alteration in some adult Copepoda. In most cases, however, the exopodite is lost and the endopodite (with the distal part of the protopodite) forms the 'palp' or may disappear altogether". In the recently discovered Mystacocarida also the biramous natatory condition of the mandible is retained in the adult (Delamare Deboutteville, 1954, 1954a) whereas in *Hutchinsoniella* the exopodite and endopodite of the juvenile mandible are lost in the adult (Sanders, 1955: 61 and fig. 2 E; 1957: 122 and fig 7 D).

In the subclass Malacostraca there is a free-swimming nauplius only in Euphausiacea and some primitive Decapoda (Penaeidea). As these nauplii do not feed



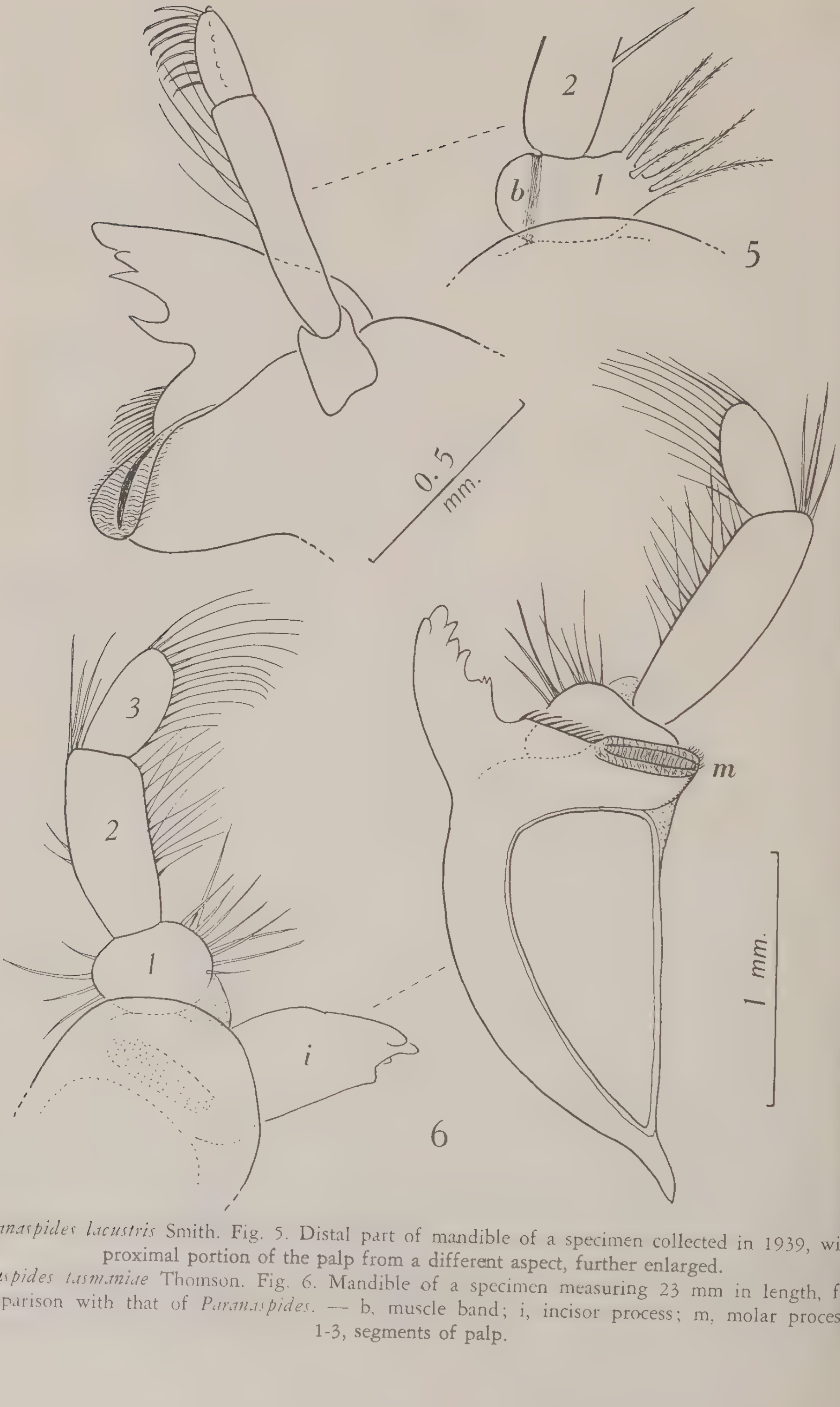
Paranaspides lacustris Smith. Fig. 3. Mandible of largest syntype in Cambridge Museum collectio from three different aspects. — Fig. 4. Incisor process of a syntype in British Museum collectio (l. = 10 mm). — i, incisor process; m, molar process; p, mandibular palp; s, spine row; 1-3 segments of palp.

there is at this stage no masticatory process. Gurney (1942: 128) says: "A remarkable feature of Decapod [= Eucaridan] development is the early loss of the mandibular palp. In Euphausiacea the biramous palp is lost in the third Nauplius, and in the Penaeidea it disappears at the moult to the Protozoea. In all other Decapoda it is absent until a relatively late stage of the larva, and in many cases it does not appear until the post-larval phase is reached".

Hickman (1937) has studied the embryonic development of *Anaspides tasmaniae* Thomson. There is the merest hint of bifurcation of the mandible in the egg-nauplius, after which the mandible loses its bilobed appearance and becomes pyriform, the narrow distal portion later giving rise to the mandibular palp (Hickman, 1937: 12 and pl. IV figs. 27-30). In the newly hatched larva there is a tiny one-segmented palp, therefore the palp must assume the adult three-segmented form at a later stage (see Hickman, 1937, pl. VI fig. 39 and fig. 6 of this paper). As fig. 6 shows, the adult mandible of *Anaspides* is in all respects very similar to that of *Paranaspides* but the palp is relatively more robust and the molar process is smaller (cf. figs. 6 and 3). Here also the basal segment is, in certain aspects, wider than the second segment and is, moreover, setose on both inner and outer margins.

In the Bathynellacea, on the other hand, the mandibular palp is gradually formed during the embryonic stages; in stage A "le palpe mandibulaire n'est encore qu'un mamelon indistinct". It commences to form in stage B, and by stage C it is now "parfaitement reconnaissable dans sa forme presque définitive, mais il est dépourvu de ses deux griffes apicales" (Chappuis and Delamare Deboutteville, 1954: 76-77, figs. 1 and 2).

To return to Smith's illustration: I think he had the misfortune to remove and figure an abnormal mandible. What struck me as odd about his figure is that the main series of marginal setae on his 'endopodite' are directed away from, not towards, the cutting edge of the mandible (cf. fig. 10 with figs. 9 and 11 in Smith, 1909). So far attempts to trace Smith's actual mandible have failed, although the bulk of his material is in the Museum of Zoology and Comparative Anatomy, Oxford. I think it highly probable that the mandible in question had, at some earlier stage in the animal's life, been damaged near the base of the palp and had regenerated what seems to be an attempt at a bifurcated palp. Bifurcation of parts as the result of injury and subsequent regeneration is not uncommon although, in Malacostraca in which the mandible is well protected by overlapping mouthparts or is concealed beneath a carapace, damage to a mandible is rare. Judging from the direction of the setae, I think that Smith's 'endopodite' must be the mirror-image part of the regenerated double-palp and that the other partner is abortive, forming the supposed 'exopodite'. This 'exopodite' has two setae; still, it is curious that Smith did not observe that in other mandibles the proximal setae are not situated where an exopodite should be, but on the other side (see figs. 1 and 2). Could he have mistaken the band of muscle for a faint suture line (fig. 5, b)? Normally no elaborate correction of a mistaken interpretation



Paranaspides lacustris Smith. Fig. 5. Distal part of mandible of a specimen collected in 1939, with proximal portion of the palp from a different aspect, further enlarged.
Anaspides tasmaniae Thomson. Fig. 6. Mandible of a specimen measuring 23 mm in length, for comparison with that of *Paranaspides*. — b, muscle band; i, incisor process; m, molar process; 1-3, segments of palp.

of a mandibular palp would be necessary. In this instance, however, rather too much theoretical importance has been given to Smith's supposed discovery of an exopodite on the mandible of a Syncarid. And Calman's remarks in a review may easily be overlooked. I have, therefore, gone into this question rather carefully and hope that eventually Smith's abnormal illustration may disappear from textbooks.

ACKNOWLEDGMENTS

When I first decided to re-examine material of *Paranaspides* I thought that the animal might well be extinct. I am particularly indebted, therefore, to emeritus Professor Hickman for enlightening me as to the present position of this Syncarid, for confirming my observations on the mandibular palp, and for sending me some of the largest of Dr. Evans's specimens collected in 1939. My thanks are also due to Dr. Manton and Professor Medawar for the gift of their only specimens to the British Museum collection; to Dr. Goodhart and Dr. Cain for the loan of syntypes; and to Dr. Holthuis and Dr. Chace for examining material in the U. S. National Museum.

RÉSUMÉ

La figure de Smith, représentant la mandibule de *Paranaspides lacustris* Smith, qui montre un endopodite et un exopodite supposé, a fait l'objet de beaucoup d'attention dans le passé. Cette illustration a été reproduite à plusieurs reprises (p. ex. dans la récente section du „Klassen und Ordnungen des Tierreichs" de Bronn traitant des Syncarida). Elle a été aussi mentionnée à l'appui de certaines conclusions théoriques exposées par Hansen. Dans ces conditions, j'ai décidé d'examiner les syntypes de *Paranaspides lacustris* et tous les autres spécimens que j'ai pu obtenir. Chez chacun des spécimens — incluant notamment plus de trente syntypes — que j'ai examinés, la mandibule ressemble à celle d'*Anaspides,* avec le palpe trisegmenté normal des Malacostracés.

Bien que l'on ne puisse maintenant retrouver trace de la mandibule figurée par Smith, on peut supposer qu'il s'agissait d'un appendice anormal. Le palpe en question avait peut-être subi une régénération à un stage quelconque du développement de l'animal, et la bifurcation qui a pu en résulter aurait donné naissance à l'anomalie figurée.

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THE TAXONOMIC STATUS OF *PANULIRUS ECHINATUS* SMITH, 1869 (DECAPODA MACRURA, PALINURIDAE)

BY

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During the examination of the Palinuridae in the collection of the U. S. National Museum, Washington, D.C., two specimens of *Panulirus echinatus* Smith were found, the study of which showed that this species, which by many authors is considered to be of doubtful standing, is distinct from all other species of the genus.

Panulirus echinatus Smith, 1869

Panulirus echinatus Smith, 1869: 20; Pocock, 1890: 516; Ortmann, 1891: 31; Rathbun, 1900: 151; De Man, 1916: 33, 44; Holthuis, 1946: 110.
Palinurus echinatus Von Martens, 1872: 125; Pfeffer, 1881: 31.
Panulirus échinatus Gruvel, 1911: 29.
Panulirus guttatus brasiliensis Faria & Silva, 1937: 44, phot. 2, 6, 7, 8, figs. 12-18.

Material examined:

Recife (= Pernambuco), Brazil; 1 July 1899; A. W. Greeley coll.; Branner-Agassiz Expedition. — 1 ♂, cl. 53 mm.
Recife (= Pernambuco), Brazil; 1875-1877; C. F. Hartt Exploration. — 1 ♂, cl. 49 mm.

The status of *Panulirus echinatus* Smith has been the object of much difference of opinion. In the original publication Smith gave an extensive description of the species, but did not provide any illustrations of it. He pointed to the close resemblance of his new species to *Panulirus guttatus* (Latreille) of which, unfortunately, he had no actual material for comparison and therefore had to rely upon H. Milne Edwards's (1837: 297, pl. 23 figs. 1, 2) account of the species. Smith already mentioned as distinguishing character between the two species the fact that the grooves of the abdominal somites are interrupted in the middle in *P. echinatus,* while they are entire in *P. guttatus.* As already pointed out by Pfeffer (1881: 31), the other differences mentioned by Smith are either unreliable or based on inaccuracies in Milne Edwards's figures of *P. guttatus.* Pfeffer (1881: 32) did not attach much value to the character of the uninterrupted grooves and came to the conclusion "dass der P. echinatus nicht als Art, vielleicht jedoch als Lokalform von P. guttatus anzusehen ist". Ortmann (1891: 30, 31) placed *P. echinatus* definitely in the synonymy of *P. guttatus.* That Pfeffer and Ortmann attached so little value to the interruption of the abdominal grooves is mainly due to the fact that they confused various species under the name *P. guttatus* and for that reason ascribed a wider range of variation to the various characters. Neither Pfeffer nor Ortmann had seen material of *P. echinatus*. Pocock (1891) and Rathbun (1900), who did examine material of that species, came to the conclusion that it is a valid species distinct from *P. guttatus*. Gruvel (1911) in his monographic treatment of the Palinuridae synonymized the two species again, while De Man (1916) and Holthuis (1946), who gave a list of the Palinuridae known to them, both treat *P. echinatus* as a distinct, though rather dubious species.

In a rather obscure publication, which has escaped the notice of most carcinologists [1]), Faria & Silva (1937) gave a very important account of the Brazilian Palinuridae. They recognized *P. echinatus* as distinct from *P. guttatus,* but believed the differences not sufficiently important to allow the two forms to stand as separate species. They considered Smith's species a variety of *P. guttatus* for which they proposed, quite unnecessarily, the new name *Panulirus guttatus brasiliensis*. They gave a good description and several figures of this variety.

An examination of the two specimens of *P. echinatus* in the collection of the U. S. National Museum, one of which is the specimen dealt with by Rathbun (1900), convinced me that Smith, Pocock and Rathbun were right in considering *P. echinatus* a full species distinct from *P. guttatus. Panulirus echinatus* is most closely related to *P. guttatus* and *P. penicillatus.* With these two species it agrees in the development of the exopods of the maxillipeds: in the first and second maxillipeds the exopod is well developed with a long flagellum, while in the third maxilliped the exopod is present but bears no flagellum at all. In all other species of the genus the exopod of the third maxilliped is either entirely absent (or at most reduced to a minute bud), or it is provided with a well developed flagellum. *Panulirus penicillatus* (Olivier), a species from the Indo-West Pacific and East Pacific regions, is immediately distinguished from the other two species in that the antennular somite bears two pairs of spines dorsally; these pairs are placed close together at their bases but diverge at the top. In *P. guttatus* and *P. echinatus,* both of which are restricted to the eastern Atlantic, the antennular somite bears only one pair of spines.

A comparison of the above specimens of *Panulirus echinatus* with actual specimens of *P. guttatus* (9 miles S. W. of Key West, Florida, in lobster trap, 8 fathoms, 19 December 1946, G. Gunter & C. E. Dawson. — 1 ♂; Havana Bay, Cuba, M. Sanchey Roig. — 1 ovig. ♀; San Geronimo, San Juan, Puerto Rico, reef and tidepools, flashlight at night, 30 April 1937, Smithsonian-Hartford Expedition, Sta. 74.— 2 ♂♂, 1 ovig. ♀; Caledonia Bay, Panama, 8°53′38″ N 77°41′25″ W, rocky reef, shore collecting, 26 April 1959, Allan Hancock Exped.

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[1]) The only reference in the literature to this publication, which I so far have found, is that by P. Sawaya (1942, Marcgrave's Hist. nat. Bras.: lxiii, lxiv). Professor Sawaya was so kind as to provide me with a photocopy of Faria & Silva's paper, for which I wish to express here my sincere thanks.

Sta. A. 50-39.— 1 ♂; Bath Reef, off Bayview, Barbados, 22 July 1959, A. G. Humes & R. U. Gooding. — 1 ovig. ♀) showed the following differences between the two species:

1. The spinulation of the carapace is very similar, but in *P. echinatus* there are more small spinules in the anterior part of the carapace in front of the cervical groove.

2. The transverse groove on abdominal somites II to V inclusive, is interrupted in *P. echinatus*; it is always continuous in *P. guttatus*. Smith described only the third to fifth somites of *P. echinatus* as having an interrupted groove, while Faria & Silva found that the groove of the second somite is interrupted in the females, entire in the males. In my two male specimens the groove of the second somite is interrupted, although the gap is smaller than in the following somites. Laterally the transverse groove of the second to fifth abdominal somites of *P. echinatus* does not reach the anterior groove of the pleura; in *P. guttatus* these two grooves join each other (fig. 1).

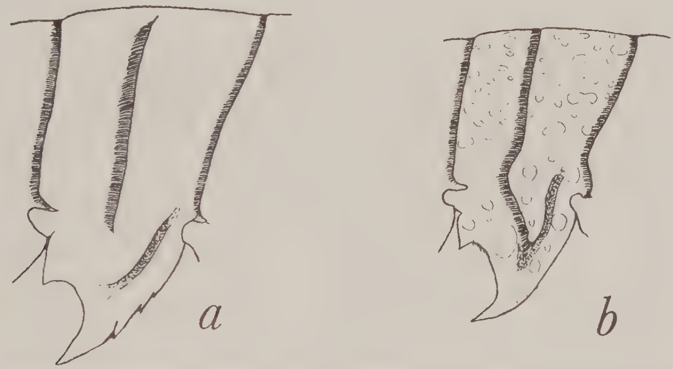

Fig. 1. Lateral view of second abdominal somite. a, *Panulirus echinatus* Smith from Recife (Branner-Agassiz Expedition). b, *Panulirus guttatus* (Latreille) from 9 miles S.W. of Key West. a, × 2; b, × 1.3.

3. The anterior margin of the first to fifth pleura of the abdomen of *P. echinatus* bears one or more distinct sharply pointed teeth, while in *P. guttatus* there are at most a few tubercles there which seldom are pointed.

4. The antennulae and antennae are relatively shorter in *P. echinatus*. The first antennular segment is definitely shorter than the distance between the cervical groove and the anterior margin of the carapace, measured in the median line. In *P. guttatus* the first antennular segment is equal to or far longer than the distance between the cervical groove and the anterior margin.

5. The spinulation of the antennal peduncle is practically the same in the two species, except that the outer surface of the last segment in *P. echinatus* is smooth, while in *P. guttatus* it bears 2 to 4 spines placed in a longitudinal row.

6. The legs are much shorter in *P. echinatus* than in *P. guttatus*.

7. The sternum in *P. echinatus* is flatter and less deeply sculptured than that

of *P. guttatus*. In the former species its posterior margin bears two short blunt tubercles medially instead of the two rather slender diverging teeth shown in *P. guttatus*.

8. Rathbun (1900: 151) described the colour of her specimen of *P. echinatus* as follows: "Carapace, antennae, first two segments of abdomen and upper half of meral joints of legs pinkish red; remainder of abdomen and legs dark blackish blue. No round spots as in *P. guttatus* (Latreille)". This colour, part of which (the bluish legs) is still to be observed in the specimen, evidently is not the natural colour, which is described by Faria & Silva (1937: 45) as follows: "violeta claro na porção dorsal e amarello claro na porção ventral; pedunculos das antennas com porções de côr violeta e outras de côr amarella; penduncuIos das antennulas com faixas longitudinaes das côres amarello e violeta; pernas tambem com faixas longitudinaes das mesmas côres que as das antenullas nos quatro primeiros segmentos; espinhos post-oculares transfaciados de amarello e violeta; abdomen semeado profusamente de manchas arredondadas, de tamanhos variados de côr amarello claro." In having the abdomen provided with many light roundish spots, *P. echinatus* thus resembles *P. guttatus*. The main colour difference between the two species seems to be that in *P. guttatus* the merus of the pereiopods is spotted, while in *P. echinatus* it is streaked with yellow and purple.

So far *P. echinatus* has only been reported from the Brazilian coast. The records in the literature are as follows: Recife (= Pernambuco), N. E. Brazil (Smith, 1869; Rathbun, 1900), Fernando Noronha (Pocock, 1890), Atoll das Roccas, W. of Fernando Noronha, 3°50′ S 33°50′ W (Faria & Silva, 1937).

Faria & Silva (1937) gave an interesting account of the biology of *Panulirus echinatus* from which the following data are taken. The species lives in natural holes in the coral reefs surrounding the islands Pharol and Cimeterio of the Atoll das Roccas. The animals were observed to leave the shelter of their holes at high tide when they went out in search of food. Of the 856 lobsters examined in the period from 1 July to 7 August 1935, 138 were males and 718 females; 217 of the latter proved to be ovigerous. Between 4 and 6 August 1935, 394 specimens were examined, 76 of these being ovigerous with eggs in different stages of development. The females are as a rule smaller than the males: the majority of the specimens of 125 to 250 mm long proved to be females, while those between 255 and 360 mm were mostly males. The largest specimen was 360 mm long; the smallest ovigerous female measured 170 mm.

ZUSAMMENFASSUNG

Panulirus echinatus Smith, 1869, ist eine gute Art, die sich von *P. guttatus* (Latreille) in einer Anzahl konstanter Merkmale unterscheidet. Die Smith'sche Art wurde von Faria & Silva (1937) ausführlich beschrieben und abgebildet unter dem Namen *Panulirus guttatus brasiliensis*.

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PHYLLODICOLA PETITI (DELAMARE ET LAUBIER, 1960) ET LA FAMILLE DES PHYLLODICOLIDAE, COPÉPODES PARASITES D'ANNÉLIDES POLYCHÈTES EN MÉDITERRANÉE OCCIDENTALE

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INTRODUCTION

Au cours de recherches faunistiques effectuées sur les fonds coralligènes du ca l'Abeille, une *Phyllodoce* sp. porteuse d'un Copépode parasite était récoltée l 19 février 1957, par dragages à 25-30 mètres de profondeur environ; il s'agissai d'une femelle adulte, bien caractérisée par ses deux longs cordons ovigères. Ce unique exemplaire ne permettant pas de faire une analyse morphologique suffisamment précise, il nous fallut attendre une nouvelle récolte pour terminer la description de cette forme qui apparaissait déjà très originale. Nous avons en effet retrouvé beaucoup plus tard, dans un milieu tout à fait différent, deux autres exemplaires de la même espèce: le 23 septembre 1960, des dragages effectués à la têt du rech Lacaze-Duthiers, par 280 mètres environ, rapportèrent quelques Corau de profondeur (*Lophelia prolifera* (Pallas)) parmi lesquels vivait un autre Phyllodocien parasité, une *Eulalia pusilla* Oersted; cette Polychète portrait deux Copépode parasites, une femelle ovifère bien visible, et un jeune stade de taille très réduite La morphologie de ces deux nouveaux spécimens les rattachait indiscutablemen à la femelle trouvée en 1957. Nous avions ainsi entre les mains trois stades d taille très différente d'une espèce nouvelle qui fut alors décrite brièvement sous l nom de *Phyllocola petiti* et rangée dans la famille nouvelle des Phyllocolida (Delamare Deboutteville et Laubier, 1960a); nous pouvions ensuite, dans un seconde note préliminaire, préciser ses affinités phylétiques avec les autres Copépodes parasites d'Annélides polychètes actuellement connus (Delamare Deboutteville et Laubier, 1960b). Le nom de *Phyllocola* ayant déja été utilisé pour désigne un genre de Coléoptères (Gistl, 1848), nous l'avons remplacé dans une note rectificative par *Phyllodicola* (Delamare Deboutteville et Laubier, 1960c); la famill correspondante doit donc porter le nom de Phyllodicolidae. Nous nous proposon ici, après avoir étudié en détail la morphologie de ces trois exemplaires, ce qu nous n'avions pu faire dans les notes préliminaires, de réunir les quelques donnée que nous avons pu recueillir sur la biologie de *Phyllodicola petiti*.

Le petit nombre d'exemplaires ne nous a pas permis d'envisager une étude ana tomique ou histologique; cependant, un des deux rhizoïdes de la femelle ovifère, qui s'était malheureusement brisé, a été fixé au Bouin, et confié pour étude à M. Yves Bouligand. Ses résultats, qui contribueront peut-être à éclaircir le problème de la nutrition de ce parasite, seront, s'il y a lieu, présentés en dehors de notre travail.

LA FEMELLE ADULTE

Fixée sur le côté droit de la Phyllodoce qui l'héberge, la femelle adulte présente extérieurement deux longs cordons ovigères et un corps assez réduit, mesurant 400 microns environ de longueur, à chitine épaisse et fortement gaufrée; la dissection de l'annélide met en évidence deux longs rhizoïdes qui s'étendent très loin dans la cavité générale de l'hôte, enchevêtrés étroitement dans la musculature des parapodes, et qui s'insinuent parfois sous le tube digestif pour passer de l'autre côté du corps; nous nous attendions malheureusement, lors de cette dissection, à rencontrer un organe interne massif et relativement court, comparable à celui des Herpyllobiidae, et ces rhizoïdes furent sérieusement mutilés; nous pouvons cependant, grâce à la femelle ovifère trouvée trois ans plus tard, préciser longueur et structure de ces appendices.

Le corps (fig. 1 a-d). Le corps, situé entièrement à l'extérieur de l'hôte, présente antérieurement un court siphon chitinisé qui traverse les téguments de l'annélide, et assure la liaison entre le corps externe et son squelette chitineux de soutien et ses rhizoïdes internes. Ce siphon est situé sur le corps au centre d'une zone faiblement chitinisée, et non gaufrée comme le reste du corps. De chaque côté de ce siphon, et en position légèrement ventrale, sont insérées deux paires d'appendices munis de griffes, les plus antérieurs courts et massifs, les plus postérieurs nettement articulés et rabattus vers le siphon buccal. Ventralement, environ au niveau du premier tiers antérieur, s'ouvrent les ,,vulves ovigères'' de structure très particulière. La paroi du corps est formée, nous l'avons vu, d'une chitine très épaisse et fortement gaufrée; d'après l'étude de la femelle immature, ce gaufrage n'est qu'une conséquence de la ponte, la sortie des œufs volumineux et assez nombreux provoquant une forte diminution du volume interne du corps. Le reste du parasite, situé en avant du siphon buccal et logé à l'intérieur de l'hôte, comporte un squelette de soutien chitineux d'où partent deux longs rhizoïdes; d'après l'étude de la plus jeune forme, cet ensemble provient du développement de la zone atriale; le corps proprement dit est donc bien entièrement situé à l'extérieur de son hôte.

Les antennes (figs. 1 f et 3 h, j). Ces deux appendices courts, trapus et de forme complexe, sont situés très près de l'ouverture du siphon buccal, mais en position légèrement ventrale par rapport à ce dernier; ceci rend évidemment difficile leur homologation avec les antennes; cependant, la présence d'antennules dorsales par rapport au siphon buccal chez la femelle ovifère, et la très grande stabilité du matériel antennaire à travers les plus fortes déforma-

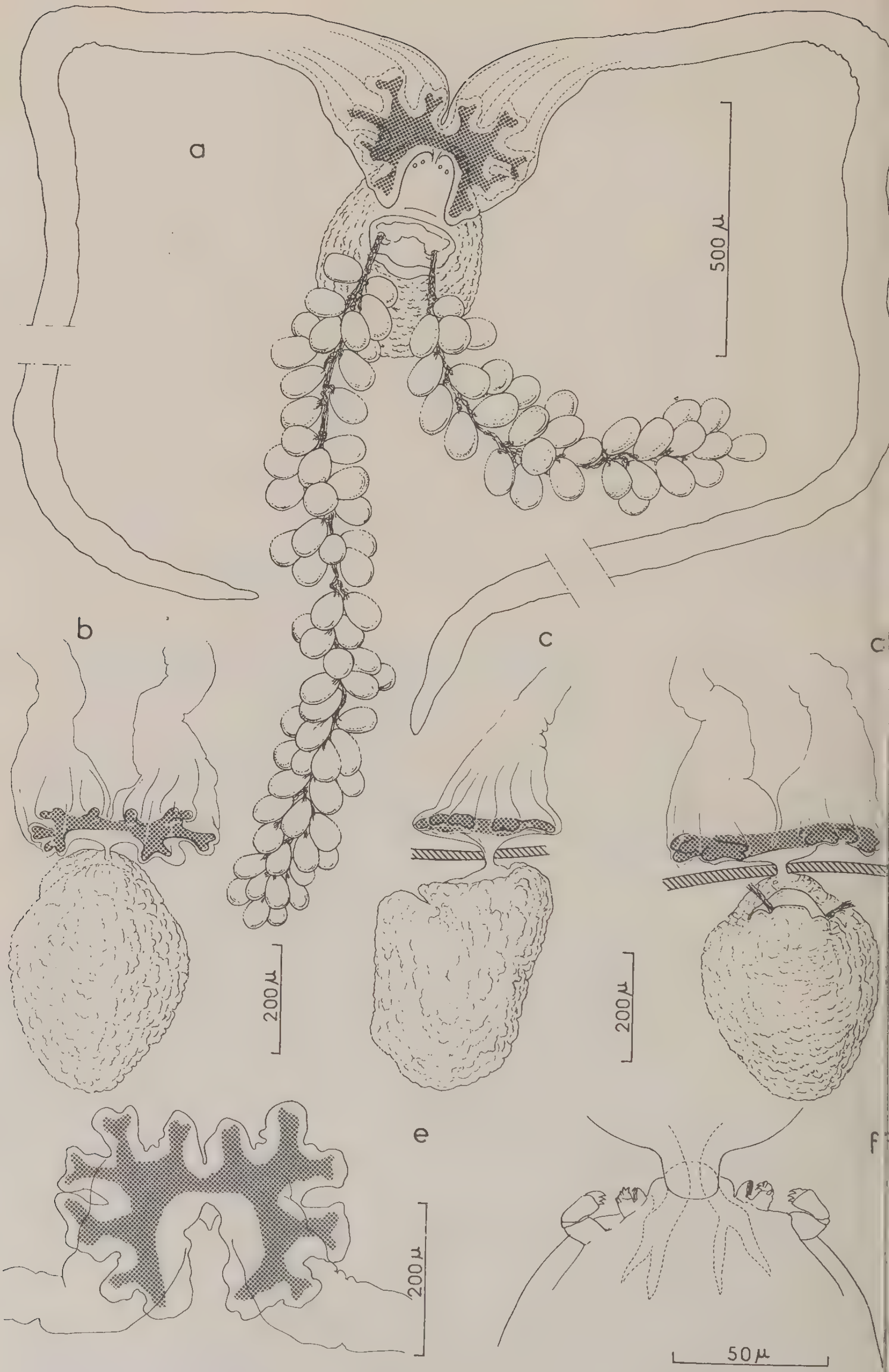
a
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Fig. 1. *Phyllodicola petiti* (Delamare et Laubier), femelle adulte. a, habitus; b, corps en vue dorsale; c, id. en vue latérale; d, id. en vue ventrale; e, anneau de soutien chitinisé en vue apicale; f, siphon buccal, antennes et maxillipèdes en vue ventrale.

tions parasitaires chez les Copépodes, sont deux arguments de poids à l'encontre du précédent; nous sommes disposés à admettre que ces appendices sont bien des antennes, mais tenons cependant à souligner le doute qui subsiste à ce sujet; peut-être une étude du cycle biologique complet permettra-t-elle de préciser cette question.

Ces antennes sont nettement bi-articulées; on distingue clairement deux sclérites annulaires reliés entre eux par une chitine articulaire plus mince; chacun de ces articles porte, sur sa face externe, un appendice renflé et court, l'appendice de l'article proximal étant finement mucroné et plus épaissi que l'autre. En outre, l'article proximal porte au niveau de la partie de chitine molle qui sépare sur son aire moyenne externe l'anneau sclérifié en deux, une zone finement pileuse, comportant deux bossettes transversales principales. Le second article se termine par deux griffes inégales, la plus interne étant de beaucoup la plus faible; ces deux griffes ont une forme en bec de perroquet très caractéristique; la sclérification poussée de ces deux griffes en fait certainement des armes solides utilisées par le très jeune stade qui se fixe.

Dans le même cadre coxal, du côté interne, il existe une formation complexe, d'interprétation délicate étant donnée la finesse des structures en cause; une puissante muraille semi-circulaire émet en direction de l'appendice proprement dit une série de fines lamelles chitineuses superposées; ces lamelles, qui vues du haut de l'appendice rappellent une pile d'assiettes, s'infléchissent vers le bas après un court trajet horizontal: elles se dirigent alors vers la paroi du corps, et viennent se terminer sur le cadre coxal, entre la base de la muraille à laquelle elles sont fixées et celle de l'article proximal de l'appendice lui-même. Grâce à cette structure, le jeune parasite peut s'accrocher solidement à son hôte dont les tissus, coincés par le jeu des griffes entre l'appendice et cette série de lamelles souples, lui offrent un support solide pour perforer tout à loisir les téguments et implanter solidement son siphon buccal, d'où naîtront support chitineux et rhizoïdes.

Les maxillipèdes (figs. 1 f et 3 h, j). Ces appendices, bien développés, sont bi-articulés; l'articulation proximale porte, entre deux sclérifications, une bande de chitine molle curieusement sinueuse qui représente peut-être les restes d'une ancienne articulation disparue.

Le premier article comporte donc deux sclérifications proximale et distale peu abondantes, séparées à peu près au milieu de l'article par cette ligne sinueuse de chitine mince. Le second article débute par une forte sclérification qui se poursuit presque jusqu'à l'extrémité de l'article, et qui supporte la griffe la plus interne; deux autres petites sclérifications distales supportent respectivement les deux autres griffes qui terminent l'article; ces trois griffes, à peu près égales, ont la même forme en bec de perroquet que celles des antennes; elles sont fortement sclérifiées. Enfin, en avant de la dernière sclérification porteuse de la griffe la plus externe, une fine ponctuation représente probablement un orifice glandulaire; la finesse de cette structure ne nous a pas permis de savoir si ce n'était pas la base d'une soie caduque; les six maxillipèdes des trois exemplaires étudiés portant tous cette même ponctuation, il est plus logique de penser qu'il s'agit bien d'un orifice glandulaire

LES „VULVES OVIGÈRES" (fig. 2 b, c et e). Pour pouvoir préciser au maximum la structure de ces formations épaisses et bien sclérifiées, nous avons dû disséquer complètement la femelle ovifère, dont les „vulves ovigères", à l'importance de la sclérification près, sont parfaitement identiques à celles de la femelle adulte.

Le terme „vulves ovigères" a une signification précise chez les Copépodes, et désigne des structures phylétiquement assez constantes; les orifices de ponte de *Phyllodicola petiti* sont beaucoup trop particuliers pour recevoir le même vocable Nous appellerons dans cette description „orifice de ponte" l'ouverture impaire d'où sortent les œufs, et „filières" les deux ouvertures latérales paires munies de dents

En vue externe, on aperçoit d'abord un cadre génital bien sclérifié qui entoure l'ensemble de l'appareil de ponte; ce cadre est directement relié de chaque côte avec les filières par des arcs chitineux puissants; entre les deux filières, une fine ligne double de chitine révèle l'existence d'une fente impaire très large, où s'ouvrent latéralement les filières elles-mêmes; cette fente correspond en quelque sorte à un atrium génital commun où débouchent filières et orifice de ponte proprement dit. De nombreux arcs chitineux consolident l'ensemble de cette formation la fente médiane reste cependant entourée de chitine fine susceptible de se distendre considérablement pour livrer passage aux œufs relativement volumineux.

En vue interne, les filières apparaissent comme deux larges orifices circulaires parois fortement sclérifiées, et totalement séparées de l'orifice de ponte; les deu dents de chacune des filières, insérées sur leur bord antérieur, s'engrènent étroitement sur le rebord postérieur où sont ménagées deux gouttières bien marquées L'orifice de ponte est nettement visible en vue interne: il possède en effet une portion sclérifiée soutenue par deux arcs latéraux eux-mêmes reliés aux sclérification des filières; cette portion interne représente donc l'extrémité d'un oviducte commun, ou, peut-être, d'un atrium véritable, s'il y a hermaphroditisme. Les filières qui sont donc distinctes de l'orifice de ponte du côté interne, débouchent, comme ce dernier, dans la fente génitale commune. Enfin, toujours en vue interne, on distingue deux fins canalicules qui viennent s'ouvrir, entre l'orifice génital e chacune des deux filières, dans la fente commune.

Les nombreuses sclérifications qui consolident cet ensemble, peu développé chez la femelle ovifère, prennent, chez la femelle adulte, une très grande importance, et rendent l'interprétation du cadre génital plus délicate; mais les structures restent cependant identiques chez l'un comme chez l'autre de ces deux stade du développement.

L'étude des cordons ovigères de *Phyllodicola petiti* (pl. VI fig. 1) va nous permettre d'expliquer le rôle de ces différentes formations: les œufs sont en effet non pas contenus dans un sac commun, mais réunis individuellement à un raphe central; l'ensemble rappelle la structure d'un épi de maïs où les grains ne seraient ni tassés les uns sur les autres, ni régulièrement disposés suivant les génératrices de

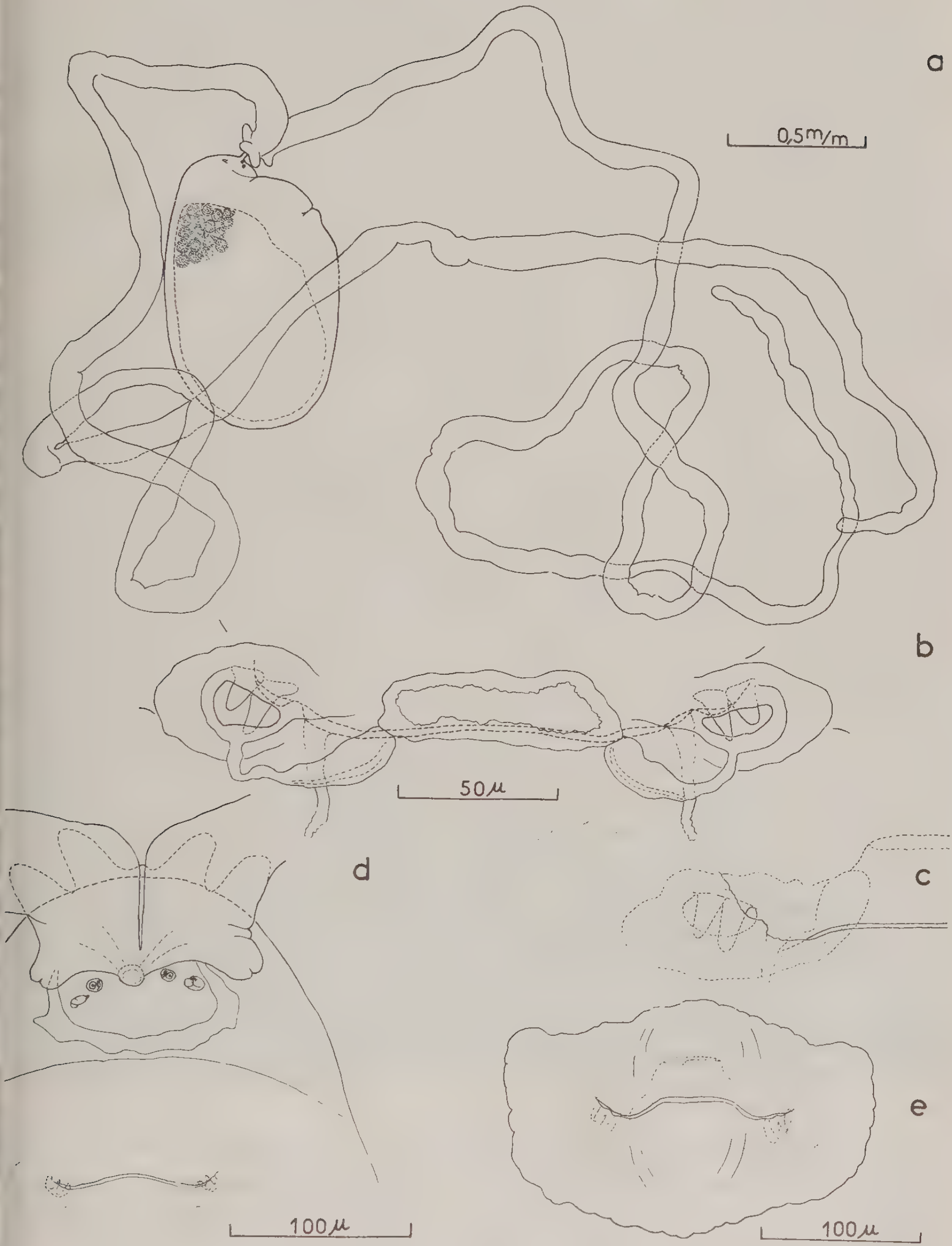

Fig. 2. *Phyllodicola petiti* (Delamare et Laubier). a-d, femelle ovifère; e, femelle adulte. a, habitus; b, les „vulves ovigères" vues de l'intérieur; c, filière droite et une partie de l'orifice de ponte; d, partie antérieure du corps en vue ventrale; e, les „vulves ovigères".

l'épi. Chaque embryon est enfermé dans une coque individuelle, rattachée au raphé central par l'intermédiaire d'un fin pédoncule probablement formé de substances cémentaires; l'axe central lui-même, examiné au microscope après éclaircissement à l'acide lactique, révèle une structure finement fibreuse: de nombreux filaments élémentaires, grossièrement enchevêtrés et réunis entre eux par une substance muqueuse qui est soluble en grande partie dans l'acide lactique, donnent finalement un raphé commun, relativement puissant, et qui supporte jusqu'à une centaine d'œufs. Ces cordons ovigères si particuliers, constituent, à notre connaissance tout au moins, une structure absolument originale; et les pontes des quelques Copépodes dont les œufs ne sont pas contenus dans un sac commun ne rappellent nullement cette structure en grappe avec un axe central.

D'après cette étude morphologique, il nous est possible de préjuger, au moins partiellement, des modalités suivant lesquelles s'effectue la ponte. Les œufs, d'après leur taille importante (130 à 140 microns de longueur), sortent à coup sûr de l'orifice de ponte; ils sont déjà certainement pourvus de leur enveloppe, mais doivent être pondus isolément, sans axe ni cordons d'attache. Les cordons élémentaires doivent sortir des filières, se coller à la coque des œufs peut-être grâce à une sécrétion émise par les deux canalicules latéraux, et finalement être réunis en un axe commun central lors de leur passage entre les dents de la filière; il est donc possible que les deux cordons se forment successivement, bien que la possibilité d'une distribution régulière des œufs émis par l'orifice de ponte à droite puis à gauche, ne doive pas être exclue a priori. Seule l'observation de la ponte de *Phyllodicola petiti* permettra de compléter ces hypothèses; l'étude morphologiqu a cependant permis de mettre en évidence un mode de ponte absolument origina chez les Copépodes, et il est probable que l'observation directe viendra pleinemen confirmer ces déductions.

LE SIPHON BUCCAL (fig. 1 f). Chez la femelle adulte, c'est un simple tube creux à parois cylindriques fortement chitinisées tout d'abord, cette sclérification devenant peu à peu moins importante du côté ventral du siphon dans sa portion distale. En effet, c'est la partie dorsale seule qui sera reliée à l'anneau de soutien chitineux situé à l'intérieur du corps de l'hôte. La paroi de ce dernier est traversée sans manifester de réactions par ce fin et solide tube chitineux, par où le parasite adulte doit se nourrir intégralement.

ANNEAU DE SOUTIEN ET RHIZOÏDES (fig. 1 a-e). La partie du parasite située à l'intérieur de l'hôte comprend une structure de soutien et d'ancrage fortement chitinisée en forme de fer à cheval lobé, d'où naissent deux longs rhizoïdes non ramifiés. Le système d'ancrage du parasite, plus ou moins régulièrement lobé, est constituée par une puissante sclérification colorée en brun foncé, comme le sont certaines chitines d'Acariens Oribates par exemple; ce fer à cheval, solidement lié à la partie dorsale du siphon buccal, est entièrement entourée par une fine peau chitineuse qui prend naissance au niveau de l'attache sur le siphon; cette chitine mince se prolonge au-dessus de l'anneau lui-même pour donner naissance à la base de chacun des deux rhizoïdes.

Ces deux rhizoïdes, d'origine paire, vont s'étendre dans la cavité générale de l'annélide jusqu'à 15 et 20 segments de part et d'autre du point de fixation du parasite; chacun de ces rhizoïdes reste dans la cavité générale, entre les muscles parapodiaux et le tube digestif; ils s'insinuent parfois sous le tube digestif pour s'étendre de l'autre côté du corps. Les dissections ne nous ont pas permis de savoir comment ces rhizoïdes traversent les obstacles offerts par les dissépiments de l'annélide. Tout ce que nous pouvons dire, c'est qu'ils sont pourvus d'une puissante musculature qui se manifeste sur le vivant par des mouvements de péristaltisme, avec formations de chapelets, contractions, extensions jusqu'à un diamètre infime, etc... Cette musculature joue certainement un rôle dans la progression des rhizoïdes à l'intérieur de la cavité générale de l'hôte. Ils se terminent en cul-de-sac, ne sont jamais ramifiés, et leur morphologie ne permet de tirer aucune conclusion sur leur rôle; ils représentent cependant à coup sûr des suçoirs à travers lesquels se nourrit le parasite, par osmose ou diffusion des liquides contenus dans la cavité générale du Phyllodocien.

Avant de traiter du parasitisme de *Phyllodicola petiti,* il nous reste à comparer à cette femelle adulte les deux autres stades plus jeunes récoltés en 1960; plutôt que de faire la description in extenso de ces deux stades, nous traiterons de leur morphologie, dans la mesure du possible, sous l'angle ontogénique.

LA FEMELLE OVIFÈRE

Le corps (pl. V, fig. 2 a, d). Le corps de la femelle ovifère est beaucoup plus gros que celui de la femelle adulte, mesurant environ 850 microns de longueur; ses parois sont lisses, il est bourré d'œufs volumineux répartis en deux groupes symétriques; c'est donc bien la ponte qui provoque le plissement profond caractéristique de la paroi du corps de la femelle adulte.

Les antennes et les maxillipèdes de la femelle ovifère correspondent exactement à ce que nous venons de décrire chez l'adulte. Par contre, située dorsalement par rapport au siphon buccal, une paire d'appendices portant une douzaine de soies correspond incontestablement aux antennules.

Les antennules (fig. 3 g). Formées d'un seul article, elles portent à leur base une forte épine bien sclérifiée, suivie d'une soie fine et allongée; vient ensuite un groupe de quatre soies disposées aux quatre angles d'un carré, une paire de soies longues et fines, et une paire de soies plus courtes et lancéolées. Cet ensemble est suivi d'une courte soie épineuse, puis d'une soie allongée, curieusement ramifiée ventralement pour porter une courte soie ventrale secondaire; un aesthetasc bien caractérisé, avec une base fortement sclérifiée et une partie distale très fine précède deux soies allongées en position dorsale; l'antennule se termine enfin par un groupe de trois soies allongées situées dans un plan dorso-ventral. Chez la femelle adulte,

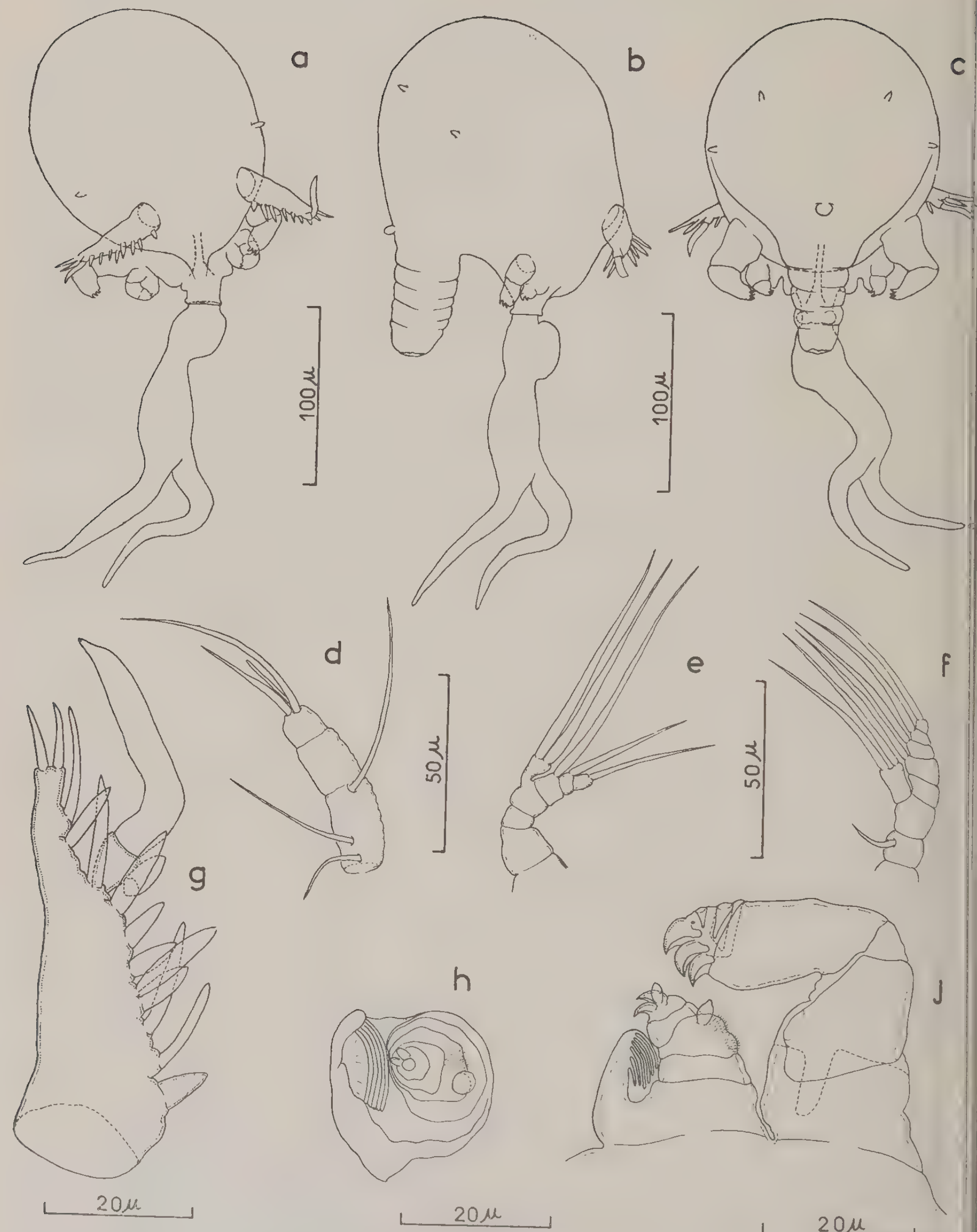
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Fig. 3. *Phyllodicola petiti* (Delamare et Laubier). a-c, g-j, jeune femelle; d-f, nauplius. a, habitus en vue dorsale; b, id. en vue latérale; c, id. en vue ventrale; d, g, antennule; e, mandibule; f, antenne; h, antenne en vue apicale; j, antenne et maxillipède en vue latérale.

ces fines antennules ont disparu, soit que la ponte provoque leur chute par le plissement de la paroi du corps, soit que les plis profonds de la cuticule les cachent alors complètement.

Les ,,vulves ovigères'' correspondent parfaitement, à l'abondance de la sclérification près, à ce que l'on observe chez l'adulte; les figures 2 b et 2 c sont d'ailleurs dessinées d'après ce spécimen ovifère.

LE SIPHON BUCCAL ET LA PARTIE INTERNE (fig. 2 a et d). Le siphon buccal est tout à fait analogue à celui de l'adulte; c'est dans la partie interne que nous rencontrons de grandes différences: au lieu de l'anneau de soutien en forme de fer à cheval lobé, nous ne trouvons qu'une ébauche de chitine encore incolore, simple massif légèrement incurvé et portant trois paires de lobes encore rudimentaires; cet appareil chitineux simplifié représente un stade de développement plus jeune que l'appareil d'ancrage et de soutien de la femelle adulte. La peau fine qui entoure cet anneau rudimentaire donne naissance vers l'avant aux deux rhizoïdes pairs, déjà presque aussi longs que ceux de l'adulte (ils s'étendent en effet de part et d'autre du point d'attache du parasite sur une douzaine de segments environ). Comme chez la femelle adulte, ils sont situés dans la cavité générale de l'hôte, entre les muscles parapodiaux, mais ne pénètrent jamais dans le tube digestif.

LE TRÈS JEUNE STADE

Il est actuellement difficile de préjuger avec quelque certitude du sexe de ce très jeune stade; la morphologie des trois paires d'appendices, strictement semblables à ceux des deux autres spécimens, la structure de l'organe interne qui s'interprète aisément comme le rudiment de l'appareil de soutien de l'adulte, en feraient une femelle. Mais l'absence de "vulves ovigères" même rudimentaires, la très forte différence de taille d'avec les stades adultes (120 contre 400 et 850 microns), la présence d'un abdomen terminant le corps et de quelques soies paires, en feraient très naturellement un mâle ne présentant qu'un très léger dimorphisme sexuel. En réalité, les ,,vulves ovigères'' peuvent fort bien n'apparaître que progressivement, l'abdomen est nettement en voie de dégénérescence, et l'identité parfaite des trois paires d'appendices avec ceux de la femelle ovifère exclut presque à coup sûr la possibilité d'une mue entre ce très jeune stade et les deux suivants; d'autre part, chez les Herpyllobiidae, Copépodes annélidicoles très dégradés, la présence d'un mâle nain à très fort dimorphisme sexuel et allure de copépodite est une règle générale. D'après ces faits, nous admettrons que ce très jeune stade est en réalité une jeune femelle, fixée depuis peu de temps sur son hôte; le mâle de *Phyllodicola petiti* resterait, s'il existe, actuellement inconnu; car, tant que des études suffisantes sur l'anatomie et l'histologie de cette forme n'auront pas été faites, nous sommes en droit de penser que ce Copépode est hermaphrodite; ceci reste actuellement du domaine de l'hypothèse, mais mérite certainement d'être précisé.

LE CORPS (fig. 3 a-c). Le corps de la jeune femelle, de taille très réduite (120 microns environ), est essentiellement caractérisé par la présence d'un abdomen légèrement replié ventralement, en voie de dégénérescence: nous ne pouvons même pas affirmer qu'il existe encore un anus fonctionnel, où vient s'ouvrir le tube digestif. L'état de dégénérescence avancée ne permet pas de distinguer autre chose qu'un orifice irrégulier dans la paroi chitineuse très mince, sans bordure bien délimitée. Au niveau de son insertion sur le corps proprement dit, l'abdomen porte dorsalement une papille impaire épaisse, étirée dans le sens transversal.

LES APPENDICES (fig. 3 a-c, g-j). Les trois paires d'appendices sont identiques à ceux de la femelle immature, et, à l'exception des antennules absentes chez cette dernière, de la femelle adulte. Le corps porte en outre deux paires de soies latérales, fortes et bien développées, qui rappellent peut-être une segmentation primitive. Les orifices génitaux sont complètement absents, aucune sclérification n'en indiquant même l'emplacement probable.

SIPHON BUCCAL ET RHIZOÏDES (fig. 3 a-c). Le siphon buccal et l'organe interne sont encore à un stade de développement très précoce; il est probable que cette jeune femelle vient juste de se fixer, arrivée au terme de sa vie planctonique. A la base du siphon, et à son intérieur, on distingue des parois internes assez fortes, et des épaississements chitineux pairs qui représentent probablement le trajet du pharynx larvaire en voie d'involution; ces structures pharyngiennes disparaissent très vite vers l'avant. Le siphon, sous forme d'un simple tube chitineux non renforcé, pénètre dans la paroi de l'hôte, où il n'est alors retenu que par un simple renflement de ses parois au niveau du tégument de l'annélide. Encore plus en avant, ce tronc commun de chitine molle se divise en deux branches minuscules, très courtes, qui deviendront plus tard les immenses rhizoïdes de l'adulte. Cet ensemble correspond donc tout à fait à une phase encore plus précoce que chez la femelle immature du système complexe de soutien et de rhizoïdes de l'adulte.

Nous avons pu observer quelques instants au microscope cette jeune femelle vivante. Nous avons d'abord constaté des mouvements de va-et-vient des antennes et des maxillipèdes, dirigés suivant une ligne joignant la base du siphon buccal à celle de chacun de ces appendices. Malheureusement, au cours de la dissection, les crampons antennaires ont cédé, le siphon buccal a légèrement glissé à l'extérieur du corps de l'hôte, et l'extrémité des maxillipèdes n'atteignait plus le tégument annélidien. Le corps du parasite contenait cependant de nombreux granules vert foncé, caractéristiques des cirres d'*Eulalia pusilla*, et qui provenaient visiblement de l'hôte; ces observations permettent de supposer que la fixation du jeune sur son hôte a lieu de la manière suivante: la larve nageuse vient activement se fixer sur la polychète par l'intermédiaire de ses antennes et maxillipèdes, et, peut-être, de pièces buccales larvaires; elle se nourrit alors par ingestion de lambeaux de chair qu'elle arrache grâce à ses puissants maxillipèdes, et subit peu à peu une profonde métamorphose, au cours de laquelle les appendices buccaux hypothétiques disparaîtraient pour donner le siphon buccal; la portion abdominale du corps subit en même temps une involution profonde et se résorbe entièrement. L'atrium buccal doit donner d'abord une espèce de troquard qui s'enfonce dans les téguments de l'hôte grâce au point d'appui solide fourni par le système antennaire, et s'y transforme plus tard en un tronc ramifié en deux rhizoïdes; l'apparition de l'anneau de soutien est beaucoup plus tardive.

LES NAUPLII

Il nous reste maintenant à décrire les nauplii de *Phyllodicola petiti,* dont nous avions eu la chance d'obtenir en 1957, après deux jours d'élevage, l'éclosion qui a lieu, d'après des notes rédigées à cette époque, de la manière suivante: „… il y a d'abord perforation de la membrane de l'œuf par un appendice nauplien, généralement l'antenne, puis la partie supérieure de la coque de l'œuf se détache totalement et tombe avec une grosse goutte de gelée. Le nauplius sort à son tour de l'enveloppe de l'œuf, et se met aussitôt à nager…". Les conditions d'élevage ne nous permirent pas alors de dépasser le stade nauplien, la plupart des larves moururent au bout de un ou deux jours, et, en aucun cas, la morphologie ne révèle l'approche de la mue métanauplienne; ces nauplii furent malheureusement perdus depuis 1957, et notre étude morphologique n'est fondée que sur des nauplii encore contenus dans la membrane de l'œuf, c'est-à-dire incomplètement développés. Nous joignons à cette description deux photographies microscopiques prises en 1957, l'extrémité d'un cordon ovigère et un nauplius éclos.

Le corps ovoïde, allongé, de très grande taille (135 microns environ) porte latéro-ventralement trois paires d'appendices naupliens typiques (pl. VI, fig. 2); terminé par deux paires de soies furcales, il ne présente, chez les nauplii encore jeunes, aucun cône buccal. Il porte dorsalement un œil tripartite typique rouge carmin.

Les antennules, uniramées et tri-articulées, sont de loin les appendices les plus développés (fig. 3 d); le premier article porte trois soies longues, le dernier article deux très longues soies natatoires dont l'une est deux fois plus longue que l'autre, et une courte soie cylindrique terminée en pointe mousse.

Les antennes sont typiquement biramées: l'exopodite est formé par cinq articles égaux dont les quatre derniers portent chacun une longue soie natatoire (fig. 3 f); l'endopodite, uni-articulé, porte deux soies longues; le premier article de la base de l'antenne porte une soie interne courte et forte, à rôle masticateur.

Les mandibules sont, elles aussi, typiquement biramées (fig. 3 e); les trois articles de l'exopodite portent chacun une longue soie natatoire; l'endopodite est identique à l'endopodite antennaire, et porte deux longues soies; trois articles inermes forment la base de cet appendice.

Cette description succincte ne mérite aucune remarque spéciale; les nauplii de *Phyllodicola petiti* ont une structure copépodienne typique, et rien n'y laisse prévoir les particularités que nous venons de décrire chez l'adulte.

DIAGNOSE

Au terme de cette étude morphologique, nous donnons de *Phyllodicola petiti* la diagnose suivante, diagnose qui, actuellement tout au moins, coïncide évidemment avec celles du genre et de la famille des Phyllodicolidae, groupements systématiques créés pour cette unique espèce: Copépode parasite à l'état adulte de Polychètes phyllodocides; corps entièrement externe; antennules présentes, ne disparaissant que chez la femelle adulte après la ponte; deux autres paires d'appendices, antennes et maxillipèdes, subsistent ventralement même chez la femelle adulte; de l'atrium buccal sort un suçoir de structure complexe chez l'adulte, très simplifié chez les stades plus jeunes, plongé dans la cavité générale de l'hôte; complètement développé, il comprend un court siphon traversant le tégument de l'hôte, une formation d'ancrage en forme de fer à cheval lobé fortement chitinisé, et d'où naissent deux longs rhizoïdes nourriciers pourvus d'une musculature péristaltique; le cadre génital comporte un orifice de ponte impair par où sortent les œufs, et deux filières latérales où sont rattachés les cordons ovigères; pas de sacs ovigères communs, les œufs sont individuellement pourvus d'un pédoncule qui les rattache à un raphé central formé par leur coalescence; le premier stade de développement est un nauplius copépodien typique.

BIOLOGIE ET AFFINITÉS

Phyllodicola petiti est donc un parasite très dégradé dont le corps reste tout entier à l'extérieur de son hôte, ce qui l'oppose directement aux Herpyllobiidés chez lesquels le „corps" externe n'est en fait que le segment génital hypertrophié; ce parasite dispose d'un ensemble de fixation et de soutien bien adapté, dont nous avons pu suivre l'ontogenèse, et d'un système d'absorption des substances nutritives par rhizoïdes rappellant certains Herpyllobiidés (*Rhizorhina ampeliscae* Hansen, 1892, par exemple) et les représentants de la très curieuse famille des Monstrillidae Dana, 1848, tout au moins pendant leur vie endoparasitaire dans le vaisseau dorsal de certaines annélides. La plus grande particularité de *Phyllodicola petiti* réside certainement dans la conformation des cordons ovigères: les quelques exceptions à la règle suivant laquelle les œufs des Copépodes sont contenus dans un sac ovigère commun sont phylétiquement très éloignées de cette forme (citons par exemple les Astérochérides, l'*Allantogynus delamarei* Changeux, etc...) et la structure de leurs vulves ovigères reste toujours classique; chez *Phyllodicola petiti* au contraire, la grande originalité des cordons ovigères correspond à une conformation adaptative des „vulves ovigères". Il semble bien d'autre part que la croissance et les transformations progressives depuis le premier stade fixé jusqu'à l'adulte se font indépendamment de toute mue, phénomène probablement courant chez de nombreux Copépodes parasites, et qui vient d'être récemment analysé chez *Nicothoe astaci* Audouin et Milne Edwards (Bocquet, Guillet et Stock, 1958).

Phyllodicola petiti, après une période de vie planctonique ou plutôt épibenthique probablement courte, puisque le nauplius est aussi grand que le plus jeune stade fixé, se fixe à un stade encore précoce sur son hôte; cette fixation s'opère grâce aux antennes et aux maxillipèdes. Il n'est pas impossible d'ailleurs que des appendices buccaux larvaires, transitoires et voués à disparaître après la fixation, mandibules et maxilles, jouent également un rôle. La larve se nourrit d'abord comme un macrophage prédateur; elle est capable d'absorber des particules importantes par une bouche larvaire qui existe certainement; elle possède encore à ce stade un tube digestif bien constitué, avec un anus débouchant à l'extrémité de l'abdomen larvaire. Puis des transformations profondes s'opèrent dans l'anatomie et la morphologie de cette larve: la bouche se ferme, les structures pharyngiennes chitinisées disparaissent peu à peu, le tube digestif régresse, l'abdomen dégénère et disparaît; en même temps, la larve enfonce dans le corps de son hôte une sorte de troquard formé par les bords de l'atrium buccal. Une fois parvenu à l'intérieur des téguments, le tube reliant la partie interne au corps externe du parasite se sclérifie fortement pour devenir le solide siphon buccal de l'adulte; plus tard, à l'intérieur de l'hôte, et lié au siphon buccal, un puissant ensemble de sclérifications va s'édifier et dessinera chez l'adulte un fer à cheval fortement lobé coloré en brun foncé. La partie distale du troquard, au-dessus de cet anneau de soutien, va se diviser en deux branches, ou rhizoïdes élémentaires, chargés d'apporter au parasite les substances nutritives prélevées au liquide de la cavité générale de l'annélide. Ces rhizoïdes vont se développer énormément, et, bien musclés, brassent et absorbent par une très grande surface les liquides qui seront ensuite conduits par le siphon buccal vers le corps de *Phyllodicola petiti.*

Ces quelques données concernant la biologie de ce parasite restent encore trop fragmentaires; en particulier, nous ne savons rien des stades libres qui suivent le nauplius, ni même s'il existe des mâles inconnus, ou si nous avons affaire à un parasite hermaphrodite. Nous avons eu trop peu de matériel pour prétendre envisager sérieusement ces problèmes, mais nous espérons pouvoir y revenir dans l'avenir.

D'après ces premières observations, le choix de l'hôte paraît se faire à un niveau familial; ceci est d'ailleurs conforme à ce qui se passe chez les Herpyllobiidés. Mais il est cependant bien possible que la spécificité parasitaire des Phyllodicolidae ne reste pas conforme à leur étymologie: la famille des Phyllodocidae, certes assez homogène, n'est pas anatomiquement très éloignée de celles des Hesionidés ou des Syllidiens. Il est fort probable, là encore, que des observations ultérieures apporteront de nouvelles données au problème de la spécificité parasitaire de *Phyllodicola petiti.*

Nous avons tenté dans une note préliminaire (Delamare Deboutteville et Laubier, 1960b) d'éclaircir les affinités phylétiques des Phyllodicolidés; parmi tous les autres Copépodes très dégradés parasites de Polychètes, cette famille nouvelle conserve indéniablement une profonde originalité morphologique, et il nous semble inutile de revenir plus en détail sur cette question. Il est par contre intéressant de souligner une fois de plus l'originalité de cette forme au sein même des Copépodes, en remarquant cependant que le manque de renseignements sur la totalité du cycle de *Phyllodicola petiti,* le nombre de types morphologiques qui restent certainement à découvrir parmi les Copépodes parasites, et l'imperfection de nombreux travaux anciens, interdisent encore, dans le cas qui nous occupe, de tenter des rapprochements phylétiques à un niveau familial.

Nous rappellerons simplement, parvenus au terme de cette étude, que les Phyllodicolidae, qui ont atteint un degré de parasitisme équivalent à celui des Herpyllobiidae à partir d'une souche probablement différente, portent les marques d'une haute diversification phylétique jointes à de nombreux caractères adaptatifs; et nous espérons que des études ultérieures parviendront peu à peu à aborder, sinon à résoudre, les nombreux problèmes qui restent encore en suspens.

SUMMARY

Phyllodicola petiti (Delamare and Laubier, 1960), belonging to the family Phyllodicolidae Delamare and Laubier, 1960, is a very curious parasitic copepod occurring on polychaete annelids of the family Phyllodocidae. Only three specimens of this new species are known: an adult female with egg-stalks, a young female and a very young stage just at the end of its free-swimming life.

The main features of this form are: body completely external to its host, attached by a strong chitinous ring on which are borne two long rhizoids which extend into the coelom of the annelid. There are three pairs of appendages: the antennule, unsegmented with fourteen setae; the antenna, two-segmented with a special apparatus for the young stage's attachment; and the two-segmented maxillipeds. The antenna and maxillipeds bear respectively two and three strong terminal hooks; the genital apparatus consists of an unpaired gonopore, and two little holes fitted with teeth ("spinnerets"). The egg-stalks are very atypical: the eggs are not held in the usual ovisacs, but are individually attached to a common axis by short and thin peduncles. To our knowledge, this special structure is unique in copepods.

The morphological description of these three stages of *Phyllodicola petiti* is followed by a brief account of its life-history and the nauplii are briefly described.

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LERNAEOCERA BRANCHIALIS (L.) A PARASITIC COPEPOD FROM THE EUROPEAN AND THE AMERICAN SHORES OF THE ATLANTIC

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In the adult stage, *Lernaeocera branchialis* (L.) infests various gadoid fishes other than haddock, *Gadus aeglefinus* L. In contrast to the recently described and apparently closely related *L. obtusa* (cf. Kabata, 1957, 1958), which is specific in the adult stage to haddock and which so far has been recorded only from the North Sea, *L. branchialis* is well-known and has been much studied on both sides of the North Atlantic. Along the shores of Europe it was recorded by many authors, some of whom (A. Scott, 1901; Schuurmans Stekhoven, 1936a, 1936b; Schuurmans Stekhoven and Punt, 1937; Sproston, 1941; Capart, 1947, 1948) described the morphology of both the adult and the larval stages in considerable detail. On the American side, C. B. Wilson (1917) gave a comprehensive account of this parasite. His descriptions were based mainly on the adult female parasite, since at that time only one juvenile specimen, taken in plankton, was available in that area. It is only recently that the larval stages of *L. branchialis* were found along the American sea-board (Reed & Dymond, 1951), parasitic on *Cyclopterus lumpus* L., a host rarely harbouring this parasite on the European side of the Atlantic.

Although a detailed comparison of *Lernaeocera* from both sides of the Atlantic has never been made, it has usually been assumed that they are conspecific. When comparing his European specimens with Wilson's descriptions, however, Schuurmans Stekhoven (1936a, 1936b) noted differences which led him to the conclusion that the American *Lernaeocera* should be regarded as a distinct species. He proposed for it the name *L. wilsoni*. Later Capart (1948) opposed this view, on the ground that not enough is known about the American form, particularly about its larval stages.

Stekhoven's view was based on three points of structural difference. His specimens differed from those described by Wilson in the structure of: (i) the first antennae, (ii) the first maxillae and (iii) the caudal laminae. It is clear, therefore, that these three appendages should be carefully studied, before the final decision about the relationship of the European and the American *Lernaeocera* can be reached.

It is an established fact that the structure of the appendages of the adult

Lernaeocera undergoes no changes after the final moult on the intermediate host. When the metamorphosis, consisting of the vigorous growth of the trunk, has taken place and the dwarfed cephalothorax has been buried in the tissues of the final host, the appendages remain unmodified. They are, however, much more difficult to examine at that stage. The best material for comparison is, therefore, the juvenile, sexually mature female from the intermediate host. It has been found that the development of the larval *Lernaeocera* is influenced to some extent by the host (Kabata, 1957, 1958), which affects particularly the size and the proportions of the body. To make two specimens fully comparable, therefore, it is preferable to collect them from the same host species.

The present author had at his disposal both adult and larval specimens of *Lernaeocera* from both sides of the Atlantic. He is indebted to Mr. V. M. Hodder of the Fishery Research Board of Canada, Biological Station, St. John's, Newfoundland, for the specimens of larval *Lernaeocera* collected from the gills of *Cyclopterus lumpus* off the Newfoundland coast, to Mr. D. J. Slinn of the Biological Station, Port Erin, Isle of Man, for similar specimens from the same host captured in the Irish Sea and to Mr. J. P. Wise of the Fish and Wildlife Service, Fisheries Laboratory, Woods Hole, for specimens of adult *Lernaeocera* from New England cod. These specimens, as well as those from the gills of flounder, *Platichthys flesus* (L.), caught along the east coast of Scotland, were examined. Each appendage was removed by fine dissection and studied under high power. Phase contrast illumination was also used. Every appendage was examined from all possible aspects. Since it is rarely possible to see clearly all the structural details in one specimen, about twenty of them were examined and the full picture, when obtained, was verified by several further examinations. Numerous sketches were made and the final drawing was produced only after the structure of each appendage was clearly understood. The text figures are not, however, composite drawings. Each figure was drawn from the most representative specimen examined.

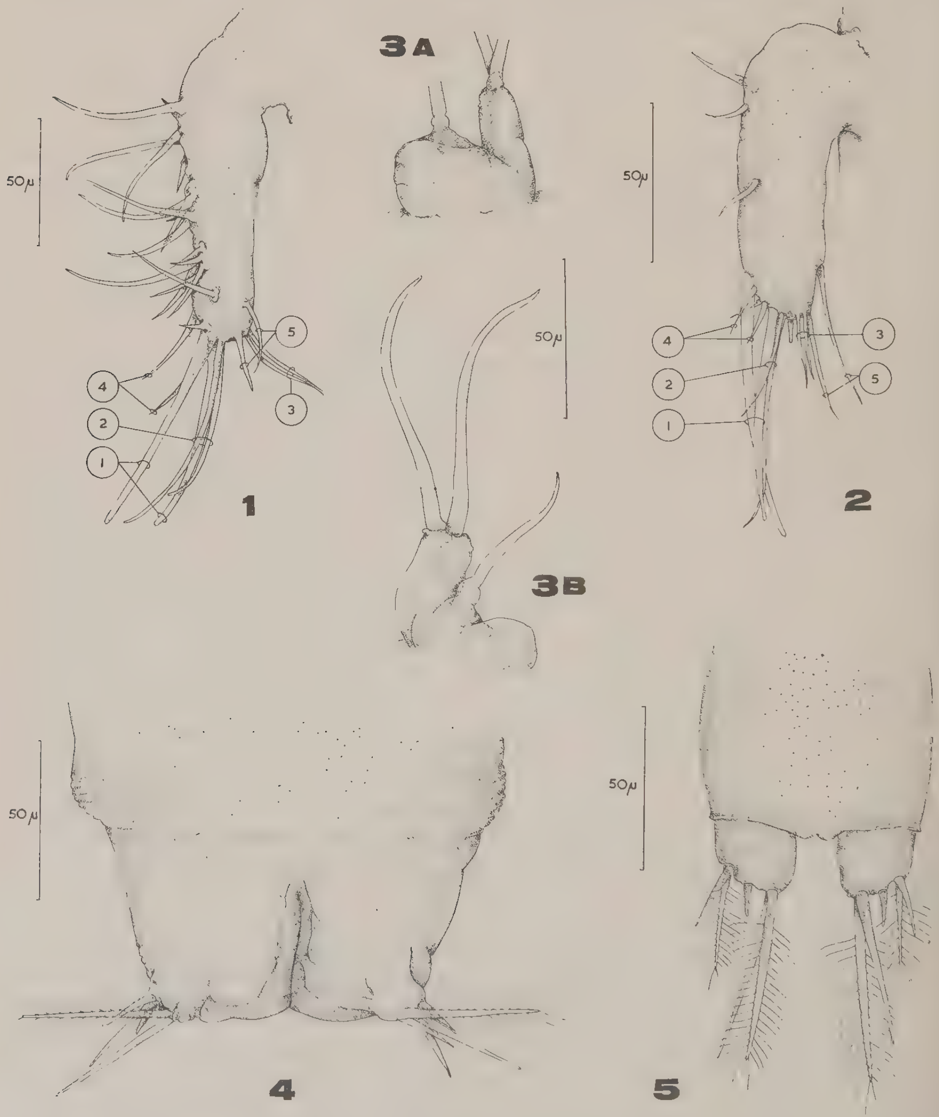
THE FIRST ANTENNAE. These small appendages have not so far been adequately described. Wilson (1917) gives only a sketchy drawing and describes them as "three-jointed and well supplied with setae". A. Scott's (1901) drawing is equally sketchy and his description states: "They are short and are composed of four, nearly equal joints furnished with fine setae." No detailed drawing is given by Schuurmans Stekhoven (1936b), who states that the first antennae "den *Lepeophtheirus*-Antennulae ähnlich sind. Am apikalen Ende findet man eine hakenförmige, dicke Borste, die für *Lernaeocera branchialis* spezifisch zu sein scheint." In another paper (Schuurmans Stekhoven, 1936a) he describes them as three- or four-jointed, with setae situated mainly near the articulations. Sproston (1941) does not illustrate the first antennae, but describes them at greater length, pointing out that they are five-jointed and richly supplied with short setae, the terminal joint bearing four stronger setae and a short curved one. Capart's (1948) drawing is much more detailed and his description is as follows: "Les antennes I . . . sont composées de

4 articles peu distinct subégaux, dont surtout le distal est orné de longues et fortes soies; les autres articles sont ornés de soies fines plus courtes."

The first antennae of both Canadian and European specimens examined by the author were identical and bore only general resemblance to those previously described for either side (fig. 1). The segmentation of the limb is rather indistinct, only the terminal joint being somewhat better defined. It is rather better observed in the male than in the female larvae. The distribution of setae along the antenna tends to indicate that it is four-segmented. The armament of the apical joint, which could be of importance in specific diagnosis, was examined with particular care. This joint is armed with twelve spines, all well recognisable and constant in shape and position of attachment, although they may appear different due to disarray caused by handling, or possibly by the movements of the appendages in life. Ten of the twelve spines are in pairs, numbered 1 to 5 in figs. 1 and 2. The main armament is provided by pairs No. 1 and 2, situated somewhat to the lateral side of the apex and usually found at a slight angle to the axis of the antenna. The setae of pair No. 1 are strong and slightly curving, with bluntly rounded tips, one being a little shorter than the other. The setae numbered No. 2 are about half the thickness of the first pair and they curve somewhat more strongly, particularly at the tips (Stekhoven's "hakenförmige Borste"?), again one being shorter than the other. (It must be remembered that the relative length of these setae is not immediately apparent from the drawing, since the angle of viewing can alter it to a large extent). Pair No. 3 is situated on the dorso-median aspect of the terminal joint. Both setae of this pair are of about the same length, slender and straight, and rather flexible, as shown by frequent undulations; their bases are close to each other. The ventro-lateral aspect of the tip, in the immediate proximity of pairs No. 1 and 2, bears setae pair No. 4; they are short and stout, very distinctly sharp-pointed, occasionally curving a little. Setae pair No. 5 is situated near pair No. 3, a little dorsal to it and pointing in the dorso-median direction. The dorsal aspect of the terminal joint, somewhat farther away from the tip, bears also two unpaired setae, which were left unnumbered in figs. 1 and 2. Three groups of setae, each consisting of five setae, are found along the lateral wall of the antennae. Their length is also difficult to determine, since they are fairly soft and are often displaced or broken off by handling.

Comparison with the first antennae of the copepodid stage shows that, in spite of many changes which the appendages undergo during the successive chalimus stages, the structure remains virtually the same. The apical joint of the first antenna at the copepodid stage (fig. 2) bears the same armament as that of the sexually mature larvae; all the twelve setae can be identified without much difficulty. The three groups of five setae of the mature animal are represented in the copepodid by three single setae, indicating that the segmentation also remains unchanged.

THE FIRST MAXILLAE. The small size of these mouth-parts, and the difficulty with which they are detached from the base of the mouth-cone, render their description difficult. It is not surprising, therefore, that no agreement exists between the accounts of the first maxillae given by various authors. A Scott (1901) does not illustrate them, but describes them as consisting of "two lobes, one of which is very small. The larger lobe has two moderately long setae at its apex, the smaller one has one seta." Wilson (1917) describes them as "short, finger-like



Figs. 1-5. *Lernaeocera branchialis* (L.). 1, dorsal aspect of the left first antenna of the mature female; 2, ventral aspect of the right first antenna of the copepodid; 3, the first maxilla of the mature female (A, ventro-lateral aspect of the entire appendage; B, lateral aspect of the base); 4, ventral aspect of the posterior tip of the trunk of the mature female, showing caudal laminae and their armament; 5, dorsal aspect of the posterior tip of the trunk of a copepodid, showing caudal laminae and their armament.

papillae, divided at the tip and each portion armed with a single large seta. On the outer margin of the papilla near the base is a small, rounded palp-like protuberance.". Schuurmans Stekhoven (1936a) states: "in the few cases where I could observe the first maxilla, this was not divided at the tip and moreover it was in the possession of three apical setae and a fourth apparently originating at the basal portion." His drawing gives no structural details. Sproston (1941) considers the first maxilla to be "in two parts, an inner short joint gradually tapering into a long seta and an outer joint also tapering off, this time into two long setae." Capart (1948) believes that the first maxillae "se composent chacune d'un segment basal massif portant 2 très longs poils épais. Chez la femelle, il existe en un plus une seconde protuberance portant une soie plus courte."

The study of the first maxillae of *Lernaeocera* from both sides of the ocean has convinced this author that they are identical. The best of the earlier descriptions appears to be that by A. Scott (1901). The base of the first maxilla consists of three protuberances: two side by side and a third one below the other two (fig. 3A, B). The inner member of the pair is more slender and its section is in the shape of an oval, with the long axis parallel to the longitudinal axis of the body. It is topped by two long and strong setae, curving ventrally and rather flexible. The outer protuberance has a wider base. It is roughly conical and its height is about one half of the inner one. It is surmounted by a single seta, similar to the other two, but rather shorter. The third protuberance is the lowest of the three and bears no setae.

The single outer seta frequently breaks off, particularly in the adult specimens from the final host. In all probability, this accounts for the absence of the third seta from Wilson's specimens, as well as from Capart's male. It is more difficult to account for the differences between the author's observations and those of Sproston, who saw this mouth-part "in reverse", with the single seta in the inner position.

There remains to be explained the presence of a fourth seta in Stekhoven's (1936a) description. This structure is identical with that described by A. Scott (1901) as the mandible. It is about as long as the longer setae of the first maxilla, blade-like in shape and has the ventral edge of the tip notched by eight sharp and slightly curving teeth, in the manner of a typical mandible. Although its base is situated immediately dorsal to the base of the first maxilla, the blade is often out of sight, since it enters the mouth-cone through a lateral slit in its wall. There is little doubt that this structure is, in fact, the mandible and that Scott observed it displaced from the buccal cone. This raises the question of the identity of the stylet-like structures, which Sproston (1941) identifies as mandibles. The structure of the buccal cone and of the mouth-parts of *Lernaeocera* require careful re-examination.

THE CAUDAL LAMINAE. No agreement exists in the literature concerning the structure of these appendages. Wilson (1917) saw them as minute plates, each surmounted by one seta. Of the European authors, Scott (1901) says: "The caudal stylets are very short and furnished with three or four short plumose setae at the apex." Stekhoven (1936b) saw in all the animals he studied "ein Büschelchen von 14 Haaren". Sproston makes no reference to these structures in the mature female, but in the male she describes them as "two small triangular processes immediately ventral to the anus; the setae on the anal laminae are four in number, the two innermost are the longest and the two outer, and slightly dorsal, are much finer and shorter."

The author examined the caudal laminae of sexually mature females from both sides of the Atlantic and found them identical. They are shown in fig. 4. The caudal laminae of these parasites form vestigial plates, each provided with five setae, two pairs not unlike those described by Sproston and a fifth one rather small and difficult to see, situated between them. The two pairs are plumose (only one on each side has been shown to be plumose in the figure, for the sake of clarity), but the single fifth seta is not.

As in the case of the first antennae, the arrangement and number of setae are the same in the case of the mature female (and, incidentally, male) as they are in the copepodid stage (fig. 5). Sproston describes the caudal laminae of the copepodid as having five long setae, her drawing illustrating them as five almost equally long setae, devoid of plumes. Fig. 5 shows two pairs of plumose setae (only one of each pair shown plumose in the figure) and a fifth, short and not plumose. The setae of each pair of about equal length, but it must be remembered that they are mobile and articulate at their bases. In some specimens, in which the influence of the preservative caused shrinkage of the tissues from the cuticle, strands of tissue can be seen leading into the setae. When seen either in dorsal or in ventral aspect, the length of the setae will depend on their angle with the long axis of the body.

CONCLUSIONS

Careful examination of the points of alleged structural differences between *Lernaeocera branchialis* from Europe and *Lernaeocera* from the Atlantic sea-board of North America, show them to be due to the inadequacies of the earlier descriptions. There are, in fact, no differences between the structures of the first antennae, the first maxillae or the caudal laminae of these two forms. Other appendages are also identical. The larvae from *Cyclopterus lumpus* on both sides of the Atlantic are identical with those from *Platichthys flesus*. No differences were found also between the adult females from the final hosts. It must be concluded that the European and the American *Lernaeocera* are conspecific.

In the study of the parasitic copepods, inadequate or inaccurate descriptions and, even more, inaccurate illustrations, are frequently responsible for mistakes in identification. In recent years two such cases were reported. Margolis (1958) compared the specimens of the Atlantic and the Pacific *Lepeophtheirus* from salmon. The latter parasite was described by Yamaguti (1939) as *L. uenoi*, but Margolis proved conclusively that Yamaguti's decision was based on inaccurate illustrations of *L. salmonis* (Krøyer) and that the two parasites are conspecific. Stuardo (1958), having examined the type specimens, became convinced that *L. ornatus* Milne Edwards and *L. insignis* Wilson are conspecific with *L. nordmanni* Milne Edwards.

By its nature, illustration by current means is of limited value for comparative study, unless accompanied by detailed description. In particular, each drawing should have appended to its caption a note of the aspect from which it was observed. Better still, if the structure of the appendage can not be understood without them, drawings of the same appendage from several aspects should be made. Higher standards of clarity and accuracy are needed.

ZUSAMMENFASSUNG

Larvenstadien der Gattung *Lernaeocera* von beiden Seiten des Atlantik werden miteinander verglichen. Besondere Aufmerksamkeit wird dabei den Antennulae, Maxillulae und Analplatten der Larven (reifer Weibchen) gewidmet. Frühere Autoren waren sich über die strukturellen Details dieser Anhänge nicht einig und eine sichere Bestimmung der Schmarotzer war daher nicht ohneweiteres möglich. Eine ins Einzelne gehende Analyse ergab, dass amerikanische und europäische Larven systematisch identisch sind und dass beide zu *Lernaeocera branchialis* gehören.

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NOTES AND NEWS

THE HOST OF THE COPEPOD *TEREDOIKA SERPENTINA* STOCK, 1959 — A CORRECTION

BY

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Teredoika serpentina is a curiously transformed copepod, endoparasitic in shipworms of the genus *Teredo*. In the original description (Stock, 1959), the host was identified by an Italian worker on Mollusca as *Teredo megotara* Hanley. The systematics of the Teredinidae is at present in a chaotic state, according to Turner (1959). It is scarcely surprising, therefore, that this determination has been questioned by the ship-worm specialist, Dr. G. Felix Roch (Venezia), who remarks (in litteris) that *T. megotara* is extremely rare in the Mediterranean, where it is not endemic, and only observed in drift-wood. On the other hand, *Teredo* (*Phylloteredo*) *utriculus* Gmelin is a common Mediterranean species, which resembles *T. megotara* to a certain extent.

After having studied the shells of the host of *Teredoika*, Dr. Roch concludes (in litt., Jan. 11, 1961) that they belong probably to *T.* (*P.*) *utriculus* and not to *T. megotara* as stated in the original publication.

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ON THE STATUS OF THE CEPHALOCARIDA

BY

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In a recent volume of Zoological Record (**94,** (10): 99), Dr. J. P. Harding and R. W. Ingle have reduced the Cephalocarida to ordinal standing and included it within the subclass Branchiopoda. No published reasons have been given for this change.

I do not agree with Harding and Ingle's action and my reasons for a subclass standing for the Cephalocarida are already known (Sanders, 1955; 1957). Until they present detailed published arguments for their contention, the scientific community has no basis for evaluating their act. Clearly then, until reasons are spelled out in exact and specific detail, this change in the status of the Cephalocarida should be rejected.

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PROPOSAL OF A NEW NAME, *LEPIDOMYSIS,* FOR THE PREOCCUPIED MYSIDACEAN GENERIC NAME *LEPIDOPS* ZIMMER, 1927

BY

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In 1924, Fage published on the occurrence of an interesting subterranean mysidacean from two small lakes supplied by underground water on the Island of Zanzibar off the east coast of Africa. In this paper he provided a description of this mysidacean, which he considered to represent a new genus and species, and gave it the name *Lepidophthalmus servatus*, placing it in a new family, Lepidophthalmidae. Zimmer (1927: 644) noted that the generic name *Lepidophthalmus* Fage, 1924, was preoccupied by *Lepidophthalmus* Holmes (1904) for a callianassid crustacean which Holmes had described from Baja California, Mexico. Zimmer therefore suggested the new generic name *Lepidops* to replace the preoccupied name *Lepidophthalmus* Fage, but he still accepted the family name Lepidophthalmidae. Stammer (1936: 54), recognizing Zimmer's change of the generic name, erected the family Lepidopidae since Zimmer had failed to do so. The name *Lepidops* Zimmer, 1927, however, is also preoccupied, namely by the name *Lepidops* Miers, 1878, for a genus of albuneid crustaceans. Stimpson (1858: 230) erected a new genus of Albuneidae which he named *Lepidopa.* He later evidently realized that this word was grammatically incorrect and in a subsequent paper (Stimpson, 1860: 113) changed the spelling to *Lepidops.* Stimpson, however, did not give an explanation for this change in spelling and so the name *Lepidops* Stimpson, 1860, must be considered an erroneous spelling of *Lepidopa* Stimpson, 1858, and it consequently has no nomenclatorial standing. Matters became different when Miers (1878: 331) adopted Stimpson's second spelling *Lepidops* and stated his reasons for doing so in a footnote as follows: "The generic name *Lepidopa* is more correctly written *Lepidops* by Stimpson in his description of *L. myops.*" Miers thus intentionally emended the name *Lepidopa* to *Lepidops* and the generic name *Lepidops* therefore has standing from 1878 on with Miers as the author. However, according to the rules of nomenclature, *Lepidopa* Stimpson, 1858, even though it has a grammatically improper ending, must be the recognized name for the genus to which it has been given; *Lepidops* Miers, 1878, being an objective junior synonym. As far as the status of *Lepidops* Zimmer, 1927, is concerned, this name is preoccupied by the available, but invalid name *Lepidops* Miers, 1878, it can not be used therefore for the genus of Mysidacea to which Zimmer applied it. For this reason, I propose the new name *Lepidomysis* as a replacement name for *Lepidops* Zimmer, 1927. Thus *Lepidophthalmus servatus* Fage, 1924, the type species of the genus must now be known as *Lepidomysis servata* (Fage, 1924), while the family name becomes Lepidomysidae.

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REVIEW

BRITISH FRESHWATER CRUSTACEA

Freshwater Biological Association — Scientific Publications:

No. 5. "A Key to the British Species of Freshwater Cladocera." By the late D. J. Scourfield and J. P. Harding. 2nd edition 1958: 1-55; text-figs. 1-111. Price 4s 10d including postage.

No. 18. "A Key to the British Freshwater Cyclopid and Calanoid Copepods." By J. P. Harding and W. A. Smith. 1960: 1-54, text-figs. 1-16. Price 4s 10d including postage.

No. 19. "A Key to the British species of Crustacea Malacostraca occurring in fresh water." By H. B. N. Hynes, T. T. Macan and W. D. Williams. 1960: 1-36, text-figs. 1-36. Price 3s 4d including postage.

The series of keys published by the Freshwater Biological Association needs no introduction to amateur microscopists, students and freshwater biologists. The key to the British species of Cladocera, first published in 1941, had been thoroughly tested and in this revised edition it has been considerably re-arranged in the light of experience. The formal key to the families has been replaced by a series of drawings, showing representative genera from each, with explanatory notes in which attention is drawn to the important characters. The illustrations have been scattered throughout the text of the key to genera and species and, as each species is reached in the key, a note on its ecology and distribution is inserted. The treatment of certain genera such as *Daphnia* and *Bosmina* has been brought into line with modern ideas and the bibliography has been brought up-to-date. In its present form the key should prove much more convenient to use and the price brings it within the reach of all who may be interested in the water fleas.

A most welcome addition to the series is the key to the British species of free-living fresh and brackish water Copepods, excluding the Harpacticids. They are more difficult to identify than the Cladocera, and Gurney's comprehensive Monograph published by the Ray Society (1931-33) is for the specialist. Much time and care have been given to the preparation of this key, which is a model of its kind and an admirable introduction to the Monograph. Gurney's classification and nomenclature have been closely adhered to and, with few exceptions, his figures are used to illustrate the key. Most of the data are derived from Gurney's work but they have been tested on all available species in the British Museum (Natural History) and amplified accordingly. The authors have found that a dichotomous key is not practicable for Diaptomids and Cyclopids; they have therefore used a tabular form in which taxonomically useful characters are compared in all the species. Clear and concise instructions are given for dissecting and mounting specimens for detailed microscopical examination. With practice the beginner should soon master the techniques and learn to use the formula keys and tables. More advanced students should find it useful for quick determinations in conjunction with the Monograph.

Scientific publication no. 19 consists mainly of keys to the determination of the freshwater species of Amphipods and Isopods. The Gammarids especially are difficult to name. Several of the British species are not included in the Faune de France Amphipod volume, now rather out of date, and much of the literature, scattered as it is in diverse periodicals, may not be readily accessible to the non-specialist. The illustrated dichotomous keys to these two orders include the important diagnostic characters, notes on ecology and where necessary on nomenclature (according to Schellenberg, 1940, however, the correct name of the *Orchestia* species should be *O. cavimana* Heller which is not a synonym of *O. bottae* from the Red Sea and East Africa). Mr. Spooner asks me to say that the third locality for *Crangonyx vejdovskyi* (Stebbing) (p. 15, last line) should read "from ground water in valley gravel at Whitchurch (Oxon.)", not "from a spring near Tavistock, Devon". A number of distribution maps and a useful list of references are given. Notes on the few British representatives of other Malacostracan orders may have been added as an afterthought, which might account for a few careless slips. For example, on p. 11 the first five abdominal somites of Mysidacea are said to be without appendages, while the poor figure of a female *Mysis relicta* Lovén shows six, instead of five, reduced pleopods (one apparently attached to the thorax). It is true that to date only one adult male of *Eriocheir* has been found in the Thames; but the mitten crab can hardly be so sensitive to pollution as Dr. Hynes suggests since it thrives in the lower reaches of such rivers as the Elbe, Weser and Rhine.

I. G.

THE TERRESTRIAL OSTRACOD OF NEW ZEALAND, *MESOCYPRIS AUDAX* SP. NOV.

BY

ANN CHAPMAN
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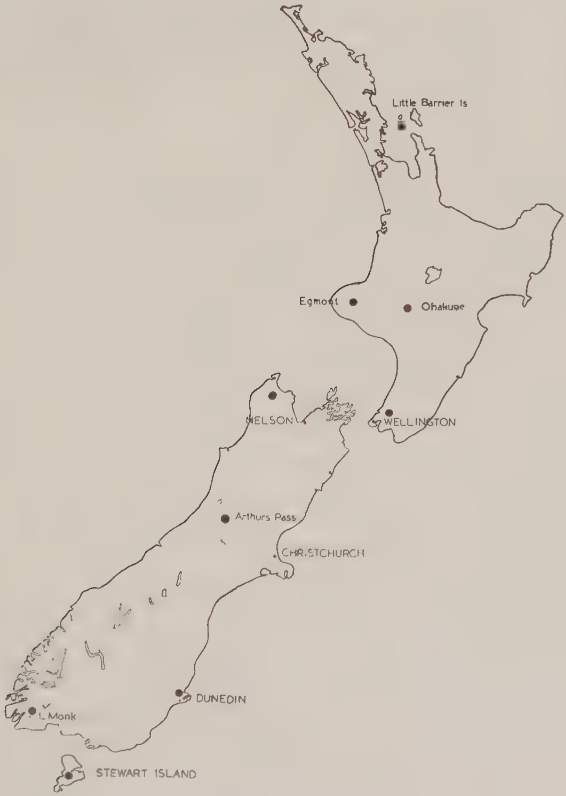
The occurrence of terrestrial ostracods in New Zealand has been known for some years, but the first published record is that of Chapman (1960). The only other known terrestrial species is *Mesocypris terrestris* from Africa (Harding, 1953); it is interesting to find that both species belong to the same genus (of the sub-family Cyprinae), although they are quite distinct. The genus was erected


Little Barrier Is
Egmont
Ohakune
NELSON
WELLINGTON
Arthurs Pass
CHRISTCHURCH
DUNEDIN
L. Monk
STEWART ISLAND

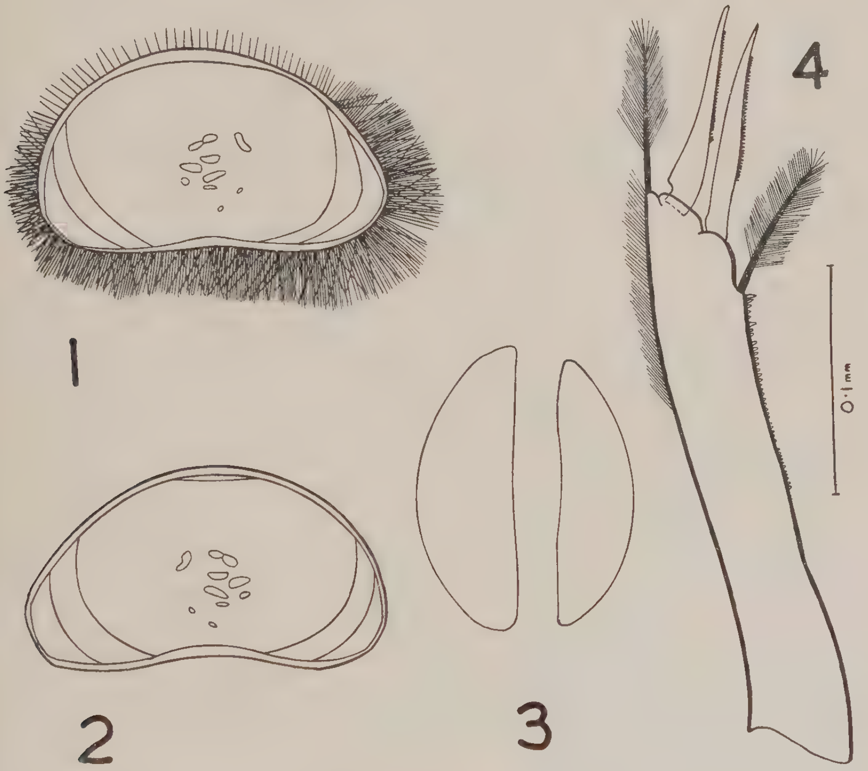
Map 1. The known distribution of *Mesocypris audax* sp. nov. in New Zealand.

by Daday (1908, 1910) for the aquatic *M. pubescens* from the slopes of Mount Kilimanjaro. Klie (1939) placed semi-aquatic forms from Kenya in the same species; his specimens were from wet moss, and also from fallen leaves dampened by the spray of a waterfall about 60 feet away.

The New Zealand species, for which I propose the name *Mesocypris audax,* in recognition of the abandonment of the usual ostracod habitat, has occurred in widely separated localities throughout the country, including at least 2 off-shore islands (map 1). It is found in the leaf mould of the native forests. This 'macrohabitat' is not affected by major vegetational differences such as those between the sub-tropical rain forest dominated by *Agathis australis* on Little Barrier Island, and the subantarctic beech forest (*Nothofagus* spp.) of Fiordland. The altitudinal range appears to be wide also, as specimens have been found in subalpine forest on Mount Egmont, and from near the bush line (altitude about 3000 feet) at Lake Monk, S. Fiordland, where the climate is harsh. This environmental tolerance is no doubt a proof of the shelter afforded by the litter. Dr. J. D. Stout (personal communication) has also taken the species from sphagnum moss. Where the ostracods occur they do so in large numbers and 20 to 30 may be obtained from a few handfuls of litter. Harpacticoid copepods are very numerous in this habitat also.

The most efficient method of collection is by means of a Baermann nematode funnel, in which the litter is immersed in water, and which is heated from above by electric lights. The heat and light cause a downward migration and in this way both young and adult forms can be collected. Another method (for older animals only) is to use a modified Tullgren funnel heated on top by a thermostatically controlled water bath. Temperatures of about 40°C appear to be best, as greater heat may cause the ostracod to close its valves and remain immobile. As this is a somewhat lower temperature than that normally used for the extraction of litter animals this may explain why *M. audax* has not been found more often. By leading the funnel into water the ostracods can be collected alive. The animals have survived (and bred) for over 6 months in a glass dish lined with moist filter paper, with fragments of humus for food. A few live specimens also survived an airmail journey to England.

M. audax is well adapted to withstand variations of the litter microclimate. The hairs on the valves will help to prevent evaporation of water. The animal reacts to light and heat, and will move rapidly away in search of protection in the crevices of rotting wood etc., but when those are not available it will close its valves tightly and remain still. If bright illumination is suddenly turned on, the valves will immediately close, but after a few moments the animal will endeavour to move away. These well developed responses will be the means of survival in a habitat liable to local variation. They are helped by the considerable speed and power of movement. The ostracod moves easily over the debris, both vertically and horizontally, often up and down steep slopes, although it has a tendency to overbalance. When this happens the 2nd antennae, 3rd legs or even the furca are waved until contact is made with something solid. The stout claws of these appendages (figs. 4, 7, 8) provide a good grip; one specimen was even seen to climb the smooth sides of a glass dish. When moving, the 1st antennae explore ahead, moving up and down, each alternating with the other. Walking is on the 2nd antennae and the 3rd legs, while in difficult places the furca is used also, the two halves acting together. The squat body shape (figs. 1-3) permits progress over or around obstacles rather than through them.



Figs. 1-4. *Mesocypris audax* sp. nov. 1, 2, internal view of left and right valves respectively of holotype (right valve with hairs omitted); 3, dorsal view of same (hairs omitted); 4, right ramus of caudal furca.

It is possible to see the movement of the normally developed respiratory plate of the maxilla, and oxygen is presumably gained from the humid air. *M. audax* is able to withstand considerable fluctuations in the water content of the habitat, migrating into damp holes in the litter and remaining immobile if conditions become too dry. It is significant that the ostracods could survive for up to a fortnight completely immersed in water.

Specimens with well developed eggs have been found from September to May, while very young ostracods were observed in mid November. No males have yet been found and it seems probable that reproduction is parthenogenetic. The eggs are apparently hatched within the mother's shell. Dissections of fully adult individuals have shown the presence of large 'eggs' with the outline of two valves showing. In no case was there a thick resistant outer covering for the egg as would be necessary for survival in the relatively dry litter environment. In a live culture, in which young specimens were suddenly noticed, no laid eggs were seen, despite regular examination. An interesting feature is the occurrence of two size classes. The majority of specimens large enough for dissection have a length of between 0.55 and 0.7 mm. A few, however, of the 30 or so measured, were much bigger, the lengths being up to 1.1 mm. These latter have always been found to have well developed eggs, while some of the smaller specimens have had younger eggs. The difference then is one of age, but whether the scarcity of the larger forms is due to a high death rate or is possibly a seasonal occurrence (although this does not seem very likely) is not clear. It should be mentioned that in a collection from Lake Monk made in January nearly all specimens were in the large size range. This was not found with any other collection, where few, if any, were big.

A direct search of leaf mould shows that the ostracods occur in the litter layer where plant remains are well advanced in rotting, and broken down into small pieces. The animals may feed on fungi or diatoms growing on this organic debris, but as the faecal pellets consist of well chewed fragments of plant remains, it seems most probable that they feed directly on the rotting leaves and twigs.

M. audax appears to be the only representative of the genus in New Zealand. Despite the extended geographical range there appears to be no sub-speciation, and specimens from each end of the range do not differ in any significant way.

I would like to acknowledge the help and advice of Professor B. J. Marples (University of Otago), who first brought the terrestrial ostracod to my notice, and of Dr. J. P. Harding (British Museum). I am also grateful to those persons who collected specimens, and to Dr. R. R. Forster (Otago Museum) and Dr. B. A. Holloway (Dominion Museum) for the loan of collections.

This paper forms part of work submitted for the degree of Master of Science (University of New Zealand).

Mesocypris audax sp. nov.

Valves oblong and moderately hairy; the left slightly the larger. Second antennae stoutly clawed, with reduced swimming setae. Mandibular palp terminated by 3 stout setae, and two shorter ones, the proximal segment with 2 long hairy setae, the vibratory plate bearing 5 thin setae. Maxilla with normal plate. First leg with 2 ventral spines, and a short vibratory plate with 5 long hairy setae. The second leg with the last 2 segments distinct, and with 2 terminal claws, the shorter one being greater than half the length of the longer one. Spines arise from the 2nd, 3rd and 4th segments. Rami of the furca symmetrical, each with 2 strongly toothed claws and a hairy seta at the end, and with a feathered subterminal seta. Hind margin of furca with groups of teeth decreasing proximally in size. Males unknown. Type locality — Leith Saddle, Dunedin (M. A. Chapman, and T. G. Marples, May 5, 1960).

Holotype is a female dissected in polyvinyl alcohol, with the valves preserved in spirit, in the Otago Museum (Dunedin, New Zealand). Paratypes in the Otago Museum and the British Museum.

Specimens were dissected under a magnification of 60 ×. Dissection and mounting were done in polyvinyl alcohol to which chlorazol black had been added. Slides were examined under ordinary illumination, and with phase contrast systems, and under oil immersion objectives. Drawings were made with the aid of a camera lucida, or with a squared eyepiece. The text of the description is supplementary to the figures.

The shell in living specimens shows an unevenly distributed lemon colour, being almost colourless over the abdomen and ovarial tubes. The larger specimens tend to be browner in colour. The left valve is slightly larger and overlaps the right valve a little at both ends. The measurements of the holotype are for the left valve: length 1.13 mm, greatest height 0.66 mm and width 0.40 mm; the corresponding measurements for the right valve are: 1.09 mm, 0.62 mm and 0.30 mm. These may be compared with the size of a smaller 'average' specimen, for which the corresponding measurements are for the left valve: 0.61 mm, 0.29 mm, 0.20 mm, and for the right valve: 0.58 mm, 0.28 mm, and 0.12 mm.

The shell (figs. 1 & 2) is moderately hairy, the hairs being longer and more numerous at each end, especially anteriorly, and ventrally. The greatest height lies behind the midline, and the valves are flattened ventrally, and to a slight extent dorsally. The selvage runs close to the outer margin of the valves anteriorly and posteriorly, but there are no crenulations of the groove of the left valve as mentioned by Harding (1953) for *M. terrestris*. The list shows clearly at each end of the valves, and the inner margin lies well beyond it.

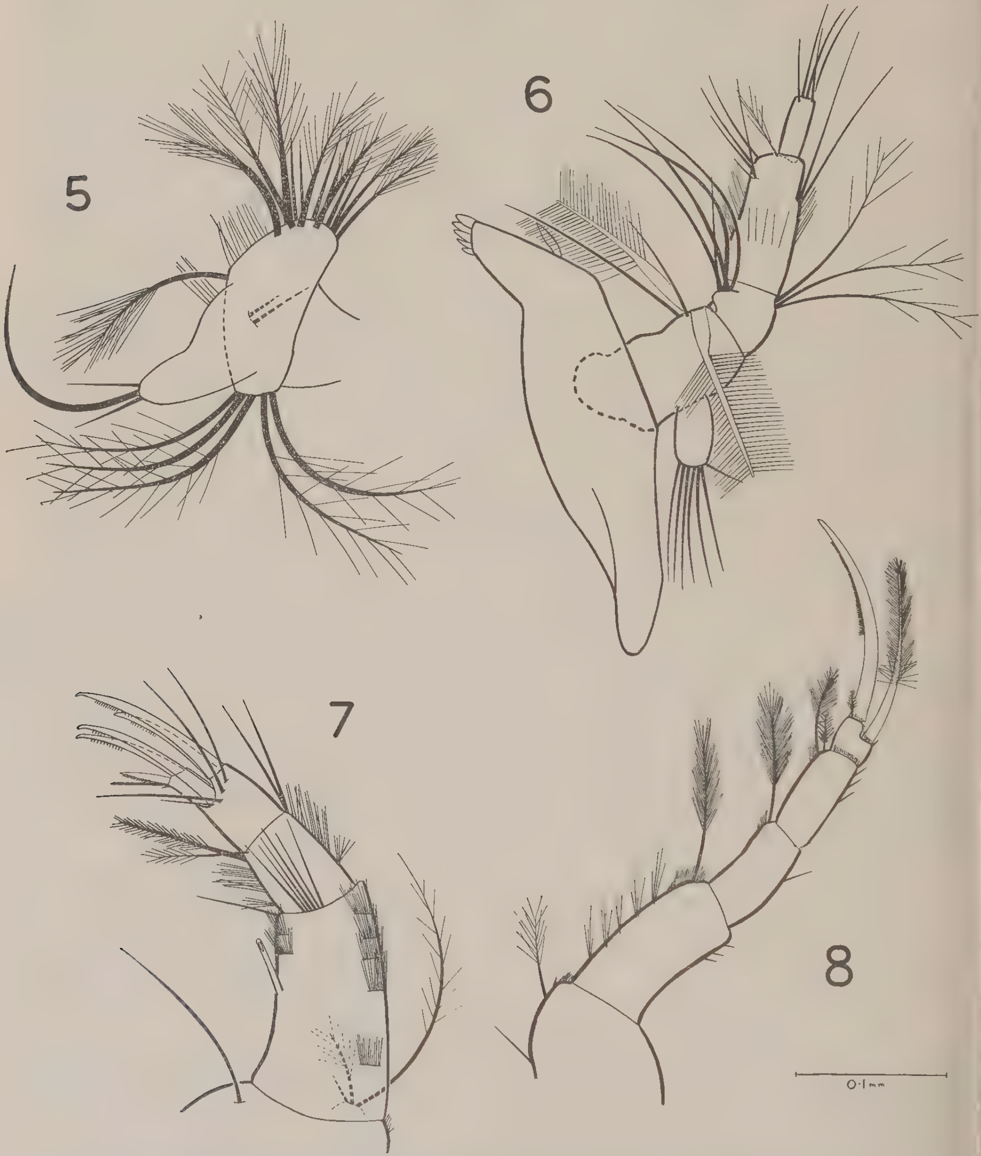
The 1st antennae are very similar to those of *M. terrestris*.

The 2nd antenna (fig. 7) is stoutly clawed with swimming setae reaching just beyond the third segment. The 3 setae arising from the base of the penultimate segment reach the end of the antennae. These are not figured by Harding but occur in *M. pubescens*. Two large claws and a smaller one arise from the penultimate segment; one long claw and one of half its length from the terminal segment. These claws have fine hairs near their ends. The segments are short and stout. The division between the penultimate and antepenultimate segments is not always distinct. The sensory seta is positioned midway along the 4th segment.

The mandibular palp (fig. 6) bears 3 long rather stout setae at the tip, and 2 shorter ones. The proximal segment bears 2 long stout setae with well developed hairs (only 1 comparable seta is seen in *M. terrestris*). I am unable to distinguish feathering in the setae of this species. The vibratory plate has 5 thin setae.

The maxilla has the normal vibratory plate and is very similar to that of *M. terrestris* and *M. pubescens* although the broad bases of the outer setae arising from the penultimate palp segment in *M. terrestris* are not seen in *M. audax*.

The first leg (fig. 5) bears thin setae, with long fine hairs on the larger ones. There are 5 very long hairy setae on the short vibratory plate; the anterior lobe has a central seta, with a short one on either side. The medial face has fine hairs along the edge, while there are two ventral spines, which are not seen in other members of the genus.



Figs. 5-8. *Mesocypris audax* sp. nov. 5, first leg; 6, mandible and palp; 7, second antenna; 8, second leg. Drawings are composites from several specimens, but holotype appendages were used as much as possible.

The 2nd leg (fig. 8) does not show the fusion of the last 2 segments mentioned by Harding for *M. terrestris*. The shorter of the two terminal claws is more powerful than in this species and is longer than half the length of the other claw. It is well feathered. Structures not seen in the African species are the 2nd shorter seta at the top of the penultimate segment, the 3 spines on this and the 4th segment, and the spine on the 3rd segment.

The 3rd leg is characteristic of the Cyprinae.

The most marked difference from *M. terrestris* is in the rami of the furca which do not show the marked asymmetry of those of other members of the genus. Each bears two strongly toothed claws (fig. 4) and a hairy seta terminally, and subterminally a posterior feathered seta (replaced by a spine in *M. terrestris*). The hind margin of the furca bears groups of teeth decreasing proximally in size. These occur on both the right and left ramus instead of on the right ramus only as in the other species of the genus.

The number of feathered setae on the appendages appears to be smaller than in *M. terrestris*.

Distribution: Lake Monk, Fiordland, Jan. 27, 1960 (M. A. Chapman); Leith Saddle, Dunedin (M. A. Chapman); Mt. Cargill, Dunedin (B. J. Marples); Flora Saddle, Nelson, from leaf mould, beech forest, alt. 3200 feet, Feb. 23, 1946 (J. T. Salmon); foot of Mount Burnett, Nelson, Jan. 6, 1956 (R. Chapman); S. E. Stewart Island, Small Craft Retreat, Jan. 23, 1955 (R. K. Dell & B. A. Holloway); foot of Mt. Rakeahua, Stewart Island, Nov. 29, 1959 (M. A. Chapman); Dawson Falls, Mt. Egmont, from leaf mould, subalpine forest, May 1954 (M. P. Buchler); Little Barrier Island, alt. 800 feet, Sep. 6, 1959 (M. A. Chapman); Silverstream, Wellington, from beech litter (J. D. Stout); Paraparamu, from sphagnum (J. D. Stout); Arthurs Pass (P. M. Johns); Ohakune, from leaf mould, Dec. 21, 1957 (P. M. Johns).

SOMMAIRE

Une nouvelle espèce d'Ostracode terrestre, la deuxième que l'on connaîsse, *Mesocypris audax* sp. nov., est décrite des forêts de Nouvelle-Zélande, où elle vit entre les feuilles mortes vermoulues.

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INTERSTITIAL COPEPODS FROM THE ISLES OF SCILLY

BY

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At the invitation of Professor L. A. Harvey of this Department a visit was made to the Isles of Scilly at Easter 1959 and collections of the interstitial fauna of the sandy beaches on four of the islands were taken during the period March 24-28.

I am indebted to Professor and Mrs. Harvey for their hospitality during my stay on the islands. Professor Harvey was also so kind to read and correct the manuscript of the present paper.

METHODS

Samples of intertidal sand from the islands of St. Mary's, St. Martin's, Tresco and St. Agnes were obtained with steel tubes of uniform diameter which were driven into the sand to depths of approximately 20 cm. As all the samples had to be transported to Exeter the number taken was necessarily limited and quantitative results were not possible.

The samples were vigorously washed to remove the animals and the copepods were picked out under a dissecting microscope. For final identification they were mounted in polyvinyl-lactophenol, with either cotton blue (0.01%) or chlorazol black (0.03%) as stain. A few specimens were dissected in this medium by hand, using needles of fine tungsten wire sharpened by dipping into molten sodium nitrite.

THE BEACHES STUDIED

The sandy beaches of the Isles of Scilly are generally composed of granite and quartz particles with a good proportion of mica fragments. Broken molluscan shell and fragments of polyzoan cases are abundant on some beaches. The westward facing shores of St. Martin's and Tresco are, at low tide, extensive sand flats. Both shores are comparatively free of tidal scour, St. Martin's more so than Tresco. Tresco Island affords St. Martin's a great deal of shelter from the prevailing westerly gales, while it itself receives rather less protection from the islands of Bryher and Samson. These factors have combined to produce conditions allowing the sedimentation of silt and both shores to have a high proportion of clayey mud mixed with the sand, which may form the bulk of the deposit below 12-15 cm.

All beaches appeared to be low in particulate organic matter in the upper layers, although no analyses were possible.

ST. MARY'S. On this, the largest island, collections were made on two beaches. The first of these is at Porthlooe, a fairly sheltered small bay facing north of west on to The Road between St. Mary's and Tresco. The beach is very flat and consists of very fine sands with a high clay content, giving it a grey colour. On this beach particulate organic matter was high on the upper shore where there was a considerable accumulation of decaying seaweed. No copepods were found and the interstitial fauna consisted of small numbers of nematodes and young stages of various polychaetes. The second beach is at Bar Point, the extreme northern tip of the island. The beach is fairly exposed. The sand is fine and clean, there being no trace of clay in the upper 20 cm. The slope is very steep and the upper shore adjoins on to an area of low sand dunes with grasses. At extreme low tide the fringe of an extensive zone of *Laminaria digitata* Lamour. is exposed. The lower shore is mainly of pebbles and small rocks.

TRESCO. The samples were taken from Appletree Bay, an extensive flat shore which covers a considerable area to the west and south-west at low water (Tresco Flats). The lower shore is studded with boulders and is very flat and remains waterlogged even at low water springs. The upper shore slopes slightly, increasing in steepness towards the land. The sand is fine and mixed with clay on the lower shore, being coarse and almost free of clay on the upper shore.

ST. MARTIN'S. Samples were taken from Old Quay on St. Martin's Flats. These flats are similar to those off Tresco but more extensive and receive more shelter. The sand is fine with much clay and with many boulders on the surface.

ST. AGNES. The twin islands of St. Agnes and Gugh are joined by a sand bar which is covered by ordinary high tides. The sand slopes away from the bar in a N.N.W. and S.S.E. direction. The northerly beach (Porth Conger) is short, of fine sand with many small surface rocks with attached algae. The southerly beach (The Cove) is much larger and free of rocks, except at the sides.

SPECIES LIST

53 species of copepods were found. The harpacticoids were mainly identified using Lang (1948) and his nomenclature is used except where indicated otherwise.

*Indicates a species new to the British fauna.

The following key is used to designate the location of the species.

1 — St. Mary's (Bar Point)
  /1 — Extreme Low Water Mark of Spring Tides (E.L.W.M.S.T.)
  /2 — Low Water Mark of Neap Tides (L.W.M.N.T.)
  /3 — c. Mid Tide Level (M.T.L.)
  /4 — Strand Line
2 — Tresco
  /1 — High Tide Level

/2 — E.L.W.M.S.T. (south-west)
/3 — E.L.W.M.S.T. (west)
/4 — *Zostera* bed at L.W.M.N.T.
3 — St. Martin's
/1 — E.L.W.M.S.T.
/2 — c. Average Low Tide Level
/3 — c. M.T.L.
/4 — c. Average High Tide Level
4 — St. Agnes — Gugh
/1 — Top of Bar
/2 — E.L.W.M.S.T. (Porth Conger)
/3 — c. M.T.L. (Porth Conger)
/4 — E.L.W.M.S.T. (The Cove)
/5 — c. M.T.L. (The Cove)

HARPACTICOIDEA

Ectinosomidae

Ectinosoma (*Ectinosoma*) *tenuipes* T. & A. Scott, 1894

4/3 — numerous ♂♂, ♀♀ & copepodites; 4/5 — 5 ♂♂, 8 ♀♀, 1 copepodite.

E. (*E.*) *melaniceps* Boeck, 1864

2/1 — 9 ♂♂, 37 ♀♀; 4/5 — 2 ♀♀.

**E.* (*Halectinosoma*) *tenerum* Sars, 1920

3/3 — 1 ♀.

Previous records: Norway, Sweden (Lang, 1948).

* **E. (H.) spinicauda** n. sp. (fig. 1)

4/2 — 15 ♀♀ Types in British Museum (Natural History), reg. no. B.M. 1960.11.14. 3-6.

This is a large species, average length 0.85 mm. Body fusiform. Rostrum large, somewhat elliptical. Antennule 6-segmented, all segments short and broad, a stout plumose spine on the terminal segment. Endopodite of antenna 3-segmented, exopodite 3-segmented, with 1 seta on basal segment, 2 on middle segment. Endopodite of maxilla reduced, with 2 long curved setae and 2 finer setae. Mandible normal. Endopodite of maxilliped short with 2 terminal setae, basipodite less than twice as long as broad. Segments of P.1 to P.4 normal, as broad as long, setae of both exopodite and endopodite spiniform and heavily plumose. Exopodite of P.5 longer than broad, with 3 apical setae and an accessory seta about the middle of the face of the segment. Outer and inner apical setae heavily plumose, middle seta with only a few scattered setae. Insertions of apical setae with a row of spinules. Baso-endopodite with 2 plumose setae of normal form, not lanceolate, inner longer than outer. Inner edge with several short setae, base with 2 rows of spinules. Caudal furcae somewhat conical, about 1½ times as long as broad, longer than the anal segment. Two large terminal lappets, 1 dorsal, 1 ventral, enclosing the bases of the apical setae. Two heavily plumose spines laterally. Two long apical setae, the outer longer than the inner.

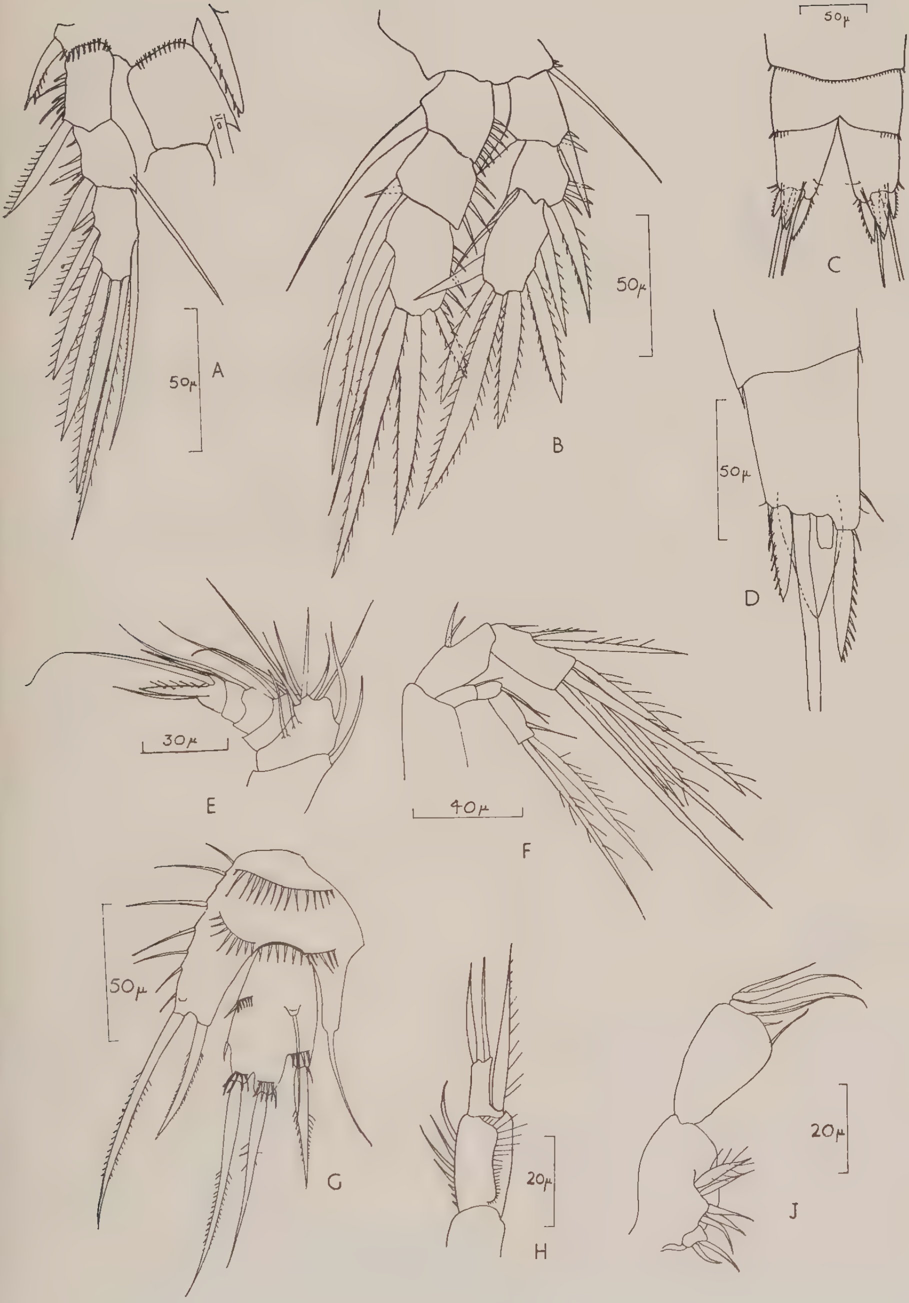
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Fig. 1. *Ectinosoma* (*Halectinosoma*) *spinicauda* n. sp., ♀. A, exopodite of P.1; B, P.4; C, furca in ventral view; D, right furca in ventral view (ventral lappet removed); E, antennule; F, antenna; G, P.5; H, maxilliped; J, maxilla.

Setal formula:

endopodites of P.1 to P.4 — 1. 1. 2.2.1.
exopodite of P.1 — 0. 1. 1.2.3.
exopodites of P.2 to P.4 — 1. 1. 2.2.3.

The setation of the exopodite of the P.5 shows that *E. spinicauda* belongs in the subgenus *Halectinosoma*; the fact that there are 3 outer setae on the distal segment of the exopodite on P.2 to P.4 places it in the *sarsi*-group. All the species included by Lang (1948) in the group are similar in setal formula and this species, differing in having only 2 inner setae on the distal segment of the exopodite of P.3 and P.4, represents a deviation from that formula while exhibiting the chief distinguishing features of the group.

The diagnostic features of this species are the peculiar spiniform nature of the setae of P.1 to P.4, the rows of basal spinules on the baso-endopodite of P.5 and spiniform caudal furcae.

**Arenosetella germanica* Kunz, 1937
1/3 — 1 ♂, 1 ♀; 3/4 — 2 ♂♂, 5 ♀♀.
Previous records: Germany (Kunz, 1937, 1954; Noodt, 1952, 1956, 1957), France (Božić, 1955; Noodt 1955a), Mediterranean (Chappuis, 1953), Madagascar (Chappuis, 1954), Seattle, U.S.A. (Chappuis, 1957).

**Pararenosetella leptoderma* (Klie, 1929)
3/2 — 2 ♀♀; 3/3 — 2 ♀♀; 3/4 — 5 ♀♀; 4/3 — 1 ♀; 4/4 — 1 ♀; 4/5 — 15 ♀♀.
Previous records: Germany (Lang, 1948; Kunz, 1949; Noodt, 1952, 1956, 1957), France (Noodt, 1955a).

P. tenuiremis (T. & A. Scott, 1894)
3/1 — 1 ♂, 2 ♀♀; 3/3 — 3 ♂♂, 4 ♀♀.
Kunz (1949) describes the male.

Tachidiidae

Thompsonula hyaenae (I. C. Thompson, 1889)
1/3 — 1 ♀.

Harpacticidae

Harpacticus gracilis Claus, 1863
2/1 — 1 ♀; 3/1 — 2 ♂♂, 9 ♀♀.

Tisbidae

Tisbe furcata (Baird, 1837)
4/2 — 1 ♀.

Thalestridae

Diarthrodes pygmaeus (T. & A. Scott, 1895)
3/4 — 1 ♂.

Amenophia peltata Boeck, 1864
2/1 — 3 ♂♂, 5 ♀♀, 6 copepodites.

Parastenheliidae

Parastenhelia spinosa (Fischer, 1860)

1/2 — 1 ♂; 2/1 — 1 ♂; 2/3 — numerous ♂♂, ♀♀ and copepodites; 2/4 — 1 ♀; 3/2 — 1 ♂, 1 copepodite; 4/3 — 1 ♂, 1 ♀; 4/5 — 2 ♀♀.

The populations were a mixture of *P. spinosa* form *typica,* form *littoralis* Sars and many which were identical with the unnamed form described by Božić (1955), which is typified by the bulbous base to the outer apical seta of the caudal furca.

P. anglica Norman & T. Scott, 1905 (fig. 2B)

2/3 — numerous ♂♂, ♀♀ and copepodites; 3/2 — 1 ♀; 3/3 — 4 ♂♂, 26 ♀♀.

Male with antennule chirocerate. P.5 small, exopodite 1-segmented with 4 setae of which only the apical is well-developed. Baso-endopodite with 2 small setae.

Diosaccidae

Bulbamphiascus imus (Brady, 1872) (fig. 2F)

3/3 — 1 ♂, 5 ♀♀; 3/4 — 11 ♂♂, 26 ♀♀; 4/2 — 2 ♂♂, 5 ♀♀.

Amphiascoides neglectus (Norman & T. Scott, 1905)

2/3 — 31 ♂♂, 30 ♀♀, 3 copepodites; 3/1 — 4 ♂♂, 38 ♀♀; 4/2 — 2 ♂♂, 5 ♀♀.

Lang (1948) ascribes this species to his new genus *Amphiascella,* but later (loc. cit.: 1619) transfers it to *Amphiascoides* Nicholls, 1941.

Typhlamphiascus blanchardi (T. & A. Scott, 1895)

3/1 — 1 ♂, 1 ♀.

T. confusus (T. Scott, 1902) (fig. 2J)

2/4 — 1 ♀.

This specimen resembles *T. confusus* in all respects except that the inner sides of the caudal furcae are straight, not concave.

Ameiridae

Ameira longipes Boeck, 1864

4/5 — numerous ♂♂, ♀♀ and copepodites; 4/1 — 3 ♀♀.

A. parvula (Claus, 1866)

2/3 — 17 ♂♂, 23 ♀♀; 2/1 — 33 ♂♂, 59 ♀♀, 10 copepodites; 4/3 — 4 ♂♂, 6 ♀♀, 1 copepodite.

A. minuta Boeck, 1864

2/1 — 6 ♂♂, 8 ♀♀.

**A. tenella* Sars, 1907

3/3 — 1 ♂, 12 ♀♀.

Klie (1950) describes the male.

Previous records: Norway (Sars, 1907), Germany (Klie, 1950; Kunz, 1954), Ireland (Farran, 1913).

A. pusilla T. Scott, 1903

3/3 — 2 ♂♂, 3 ♀♀.

A. tenuicornis T. Scott, 1902 (fig. 2A)

2/1 — 3 ♀♀; 3/1 — 3 ♂♂, 11 ♀♀.

Male with sub-chirocerate antennule. Baso-endopodite of P.5 with only 2 setae of which the outer is small and the inner lanceolate. Exopodite of this leg with 5 setae.

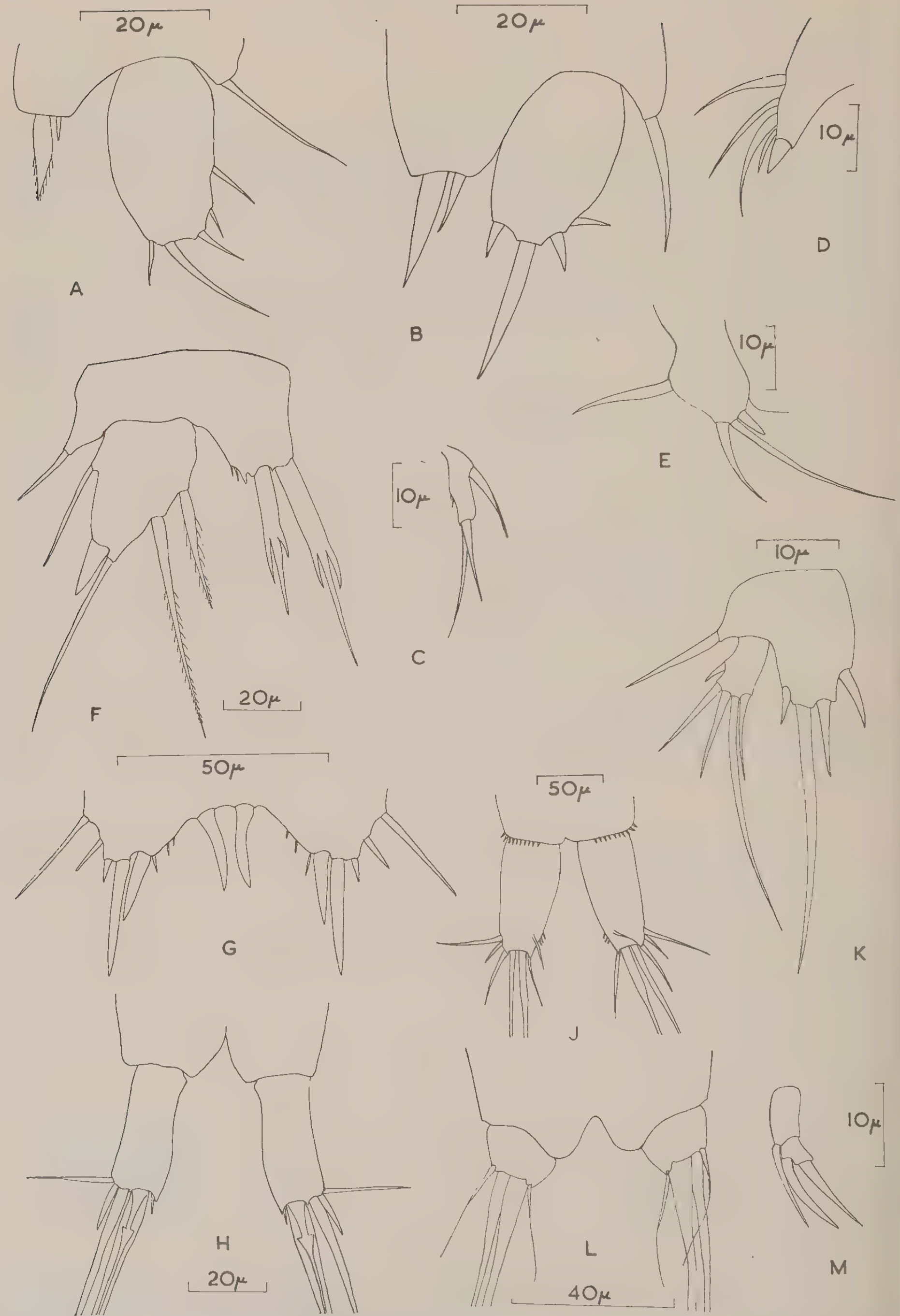
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Fig. 2. A, *Ameira tenuicornis* T. Scott, ♂. B, *Parastenhelia anglica* Norman & T. Scott, ♂. C-E, *Leptopsyllus littoralis* Nicholls, ♂. F, *Bulbamphiascus imus* (Brady), ♂. G, H, *Pteropsyllus* sp., ♂. J, *Typhlamphiascus confusus* (T. Scott), ♀. K-M, *Nitocrella halophila brevifurca* n. subsp., ♀. A, B, D, F, G, K, P.5; C, M, exopodite of antenna; E, P.6; H, J, L, furca in ventral view.

**Leptomesochra eulittoralis* Noodt, 1952
2/1 — 2 ♂♂, 24 ♀♀.
Previous records: Germany (Noodt, 1952, 1956, 1957), France (Noodt, 1955a).

**L. tenuicornis* Sars, 1911
3/3 — 1 ♀.
Previous record: Norway (Sars, 1911).

**Psyllocamptus minutus* Sars, 1911
2/4 — 4 ♀♀.

Previous records: Norway, Sweden (Lang, 1948), Germany (Kunz, 1954), Black Sea (Noodt, 1955), South-West Africa (Kunz, 1951).

* **Nitocrella halophila** Noodt, 1952, subsp. **brevifurca** nov. (fig. 2K-M)
3/4 — 1 ♂, 8 ♀♀. Types in British Museum (Natural History) reg. no. B.M. 1960. 11.14. 1,2.

Exopodite of antenna 2-segmented with 1 seta on first segment, 2 on second segment. P.1 to P.4 identical to those of *N. halophila* s.str. P.5 of female with 4 terminal setae and 1 small outer seta; baso-endopodite with 4 setae, the outermost very small. P.5 of male as in *N. halophila* s.str. Caudal furcae only as broad as long.

Previous records (of typical form): Germany (Noodt, 1952, 1956, 1957).

Paramesochridae

Paramesochra minor (T. & A. Scott, 1895)
4/2 — 1 ♀; 4/3 — 2 ♀♀.

P. intermedia (T. & A. Scott, 1895)
2/2 — 28 ♂♂, 94 ♀♀, 4 copepodites; 2/3 — 28 ♂♂, 100 ♀♀; 3/1 — 2 ♂♂, 40 ♀♀; 4/4 — 1 ♀.

P. herdmani (Thompson & A. Scott, 1899)
4/3 — 3 ♀♀.

Remanea arenicola Klie, 1929
2/1 — 2 ♂♂, 14 ♀♀, 1 copepodite; 3/3 — 1 ♀.

Leptopsyllus littoralis Nicholls, 1939 (fig. 2C-E)
2/3 — 1 ♂.

This specimen differs from Nicholls' type in having only 3 setae on the exopodite of the antenna, and thus is similar in this respect to the females described by Chappuis (1953) from Tunisia.

Tetragonicepsidae

**Phyllopodopsyllus longicaudatus* A. Scott, 1909
3/1 — 1 ♂.
Previous record: Paternoster Island, Indonesia (A. Scott, 1909).

Pteropsyllus sp. (fig. 2G-H).
3/1 — 2 ♂♂.

Antennule sub-chirocerate. Endopodite of P.1 3-segmented, those of P.2 to P.4 2-segmented. Exopodite of P.1 to P.4 3-segmented. The two P.5 are fused in the mid-line to a single plate. Furcae twice as long as broad. These specimens differ from *P. consimilis* (T. Scott, 1894) in having fused P.5 and in details of the caudal furcae; from *P. plebius furcatus* Kunz, 1938 in having no anal projections;

from *P. plebius* Monard, 1935 in having longer furcae. The setal formula — P.2 to P.4 exopodite — 0. 0. 0.2.2., endopodite — 1. 0.2.0. — is that given by Lang (1948) for the genus but differs from that of *P. plebius furcatus* given by Kunz (1938). It is probable that these specimens are aberrant males of *P. consimilis.*

Canthocamptidae

**Itunella muelleri* (Gagern, 1922)

1/4 — 2 ♀♀; 3/4 — 2 ♂♂, 1 ♀.

Previous records: Germany (Lang, 1948; Kiefer, 1960; Noodt, 1956, 1957), Sweden (Noodt, 1954; Brinck et al., 1955), France (Chappuis, 1954a), Ireland (Roe, 1958).

Cylindropsyllidae

Paraleptastacus spinicauda (T. & A. Scott, 1895)

1/3 — 1 ♂, 4 ♀♀; 2/3 — 12 ♂♂, 34 ♀♀; 3/1 — 2 ♂♂, 7 ♀♀; 3/3 — 3 ♂♂, 13 ♀♀, 1 copepodite; 4/1 — 5 ♀♀; 4/3 — 2 ♀♀; 4/4 — numerous ♂♂, ♀♀ and copepodites; 4/5 — 8 ♂♂, 9 ♀♀.

Evansula pygmaea (T. Scott, 1903)

3/1 — 19 ♂♂, 29 ♀♀; 3/3 — 25 ♂♂, 23 ♀♀; 3/4 — 4 ♂♂, 1 ♀; 4/4 — 2 ♂♂, 2 ♀♀.

**Arenopontia subterranea* Kunz, 1937

3/4 — 13 ♂♂, 79 ♀♀, 21 copepodites.

Previous records: Germany (Lang, 1948; Noodt, 1952, 1956, 1957), France (Chappuis, 1954a, Noodt, 1955a), Mediterranean (Chappuis, 1953; Delamare-Deboutteville, 1953), Black Sea (Noodt, 1955), Madeira (Delamare-Deboutteville, 1960).

**Psammotopa phyllosetosa* (Noodt, 1952)

3/2 — 1 ♀; 3/3 — 1 ♂, 2 ♀♀; 3/4 — 3 ♂♂, 3 ♀♀.

Previous records: Germany (Noodt, 1952, 1953, 1956, 1957), France (Noodt, 1955a).

Leptastacus macronyx (T. Scott, 1892)

2/2 — 12 ♂♂, 24 ♀♀; 2/3 — 2 ♂♂, 5 ♀♀; 3/1 — 1 ♀.

**L. laticaudatus intermedius* Kunz, 1938

2/2 — 1 ♂, 9 ♀♀; 2/3 — 2 ♂♂, 5 ♀♀; 3/1 — 1♀.6 ♀♀, 1 copepodite.

Previous record: Germany (Kunz, 1938).

Leptopontia curvicauda T. Scott, 1902

2/2 — 1 ♂; 2/3 — 1 ♀; 3/1 — 1 ♀.

Cletodidae

Rhizothrix gracilis (T. Scott, 1903)

2/2 — 2 ♂♂, 1 ♀; 2/3 — 1 ♂; 3/2 — 2 ♂♂, 2 ♀♀; 3/3 — 5 ♂♂, 9 ♀♀; 3/4 — 1 ♀, 1 copepodite; 4/1 — 8 ♀♀; 4/2 — 4 ♀♀; 4/3 — 1 ♀; 4/4 — 4 ♀♀, 1 copepodite; 4/5 — 23 ♂♂, 128 ♀♀.

Laophontidae

Asellopsis intermedia (T. Scott, 1895)

2/3 — 1 ♂; 3/1 — 1 ♀; 3/3 — 5 ♂♂, 7 ♀♀; 4/2 — 1 ♂, 9 ♀♀; 4/4 — 4 ♀♀.

Heterolaophonte minuta (Boeck, 1872)
2/1 — 2 ♀♀; 3/2 — 1 ♀.

Esola longiremis (T. Scott, 1904) (fig. 3 B-C)
3/2 — 1 ♂.

This specimen does appear to exhibit the main characters of the species, as shown by the female; distal segment of exopodite of P.3 with 3 outer spines; exopodite of P.1 3-segmented; furcae about twice as long as broad. Antennule sub-chirocerate. Endopodite of P.3 3-segmented. Baso-endopodite of P.5 with 2 small setae, exopodite longer than broad with 3 setae. P.6 with 2 long setae.

Pseudolaophonte spinosa (I. C. Thompson, 1893)
3/1 — 2 ♀♀; 3/2 — 1 ♀.

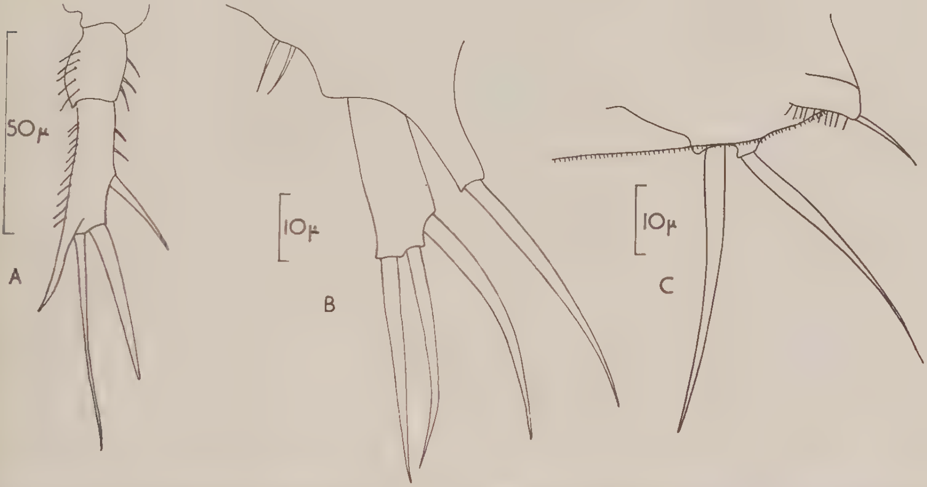

Fig. 3. A, *Onychocamptus kliei* (Monard), ♂. B, C, *Esola longiremis* (T. Scott), ♂. A, endopodite of P.3; B, P.5; C, P.6.

**Pseudonychocamptus koreni* (Boeck, 1872)
4/1 — 7 ♂♂, 2 ♀♀, 1 copepodite.

Previous records: Norway, Sweden (Lang, 1948), Germany (Lang, 1948; Klie, 1950), Tunisia (Lang, 1948), Ireland (Farran, 1913; Roe, 1958, 1960).

**Onychocamptus kliei* (Monard, 1935) (fig. 3 A)
2/1 — 2 ♂♂; 4/3 — 1 ♂.

The male is described by Noodt (1955a) and, as form *adriatica*, by Petkovski (1954). The present specimens agree more closely with Petkovski's account, particularly in regard to the exopodite of P.4 in which the outermost seta on the distal segment is spiniform. The endopodite of P.3 is more highly modified than that figured by Noodt or that described by Petkovski.

Previous records: France (Monard, 1935; Chappuis, 1954a; Noodt, 1955a), Yugoslavia (Petkovski, 1954, 1955).

Heterolaophonte sp. (fig. 4)
2/1 — 1 ♂; 4/3 — 1 ♂.

These specimens resemble no known male of the genus, but since some males remain undescribed, and those that are known differ so much from the females, it is considered unwise to ascribe these specimens to any known species, or to erect a new species for them.

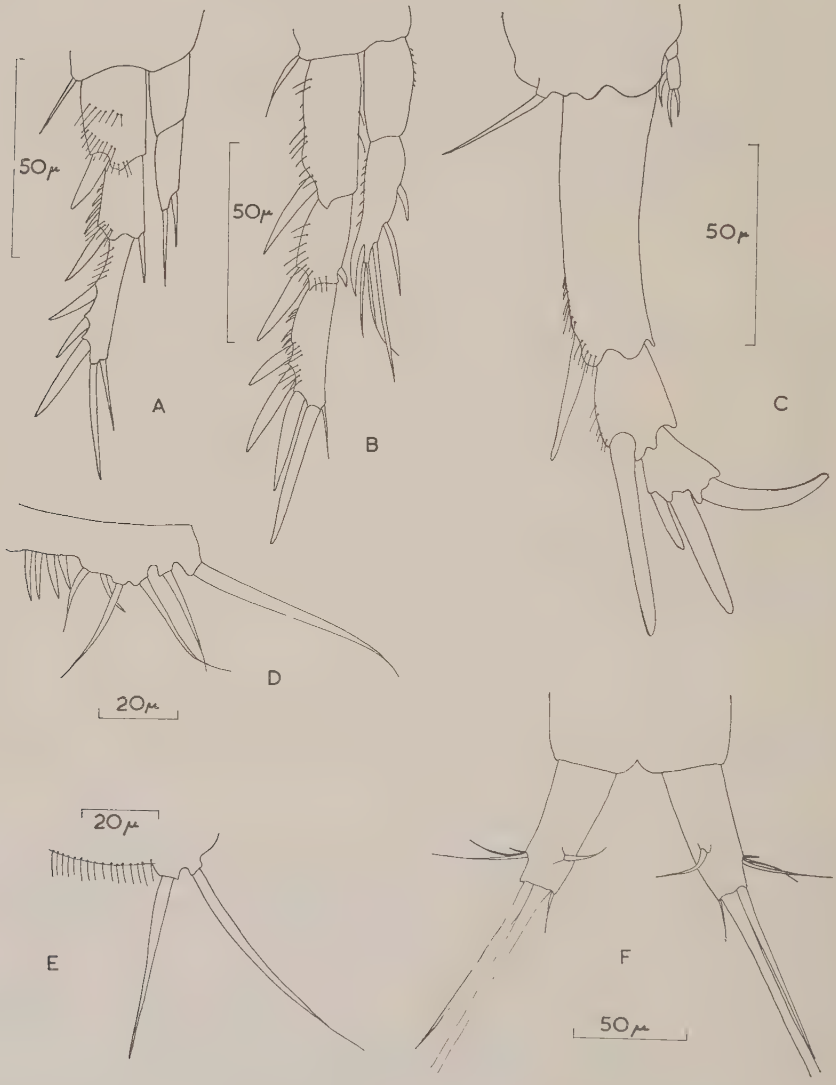

Fig. 4. *Heterolaophonte* sp., ♂. A, P.2; B, P.3; C, P.4; D, P.5; E, P.6; F, furca in ventral view.

Antennule chirocerate. Exopodite of the antenna rudimentary. Exopodite of P.1 3-segmented. Endopodite of P.2 to P.4 2-segmented. Basal segment of endopodite of P.2 and P.3 without inner seta, distal segment of endopodite of P.2 with only 2 setae. Exopodite of P.5 fused with baso-endopodite. P.6 with 2 long setae. Furca about twice as long as broad with both apical setae well-developed.

Ancorabolidae

Laophontodes bicornis A. Scott, 1896
2/1 — 1 ♂.

CYCLOPOIDEA

Cyclopinidae

Cyclopina norvegica Boeck, 1864
2/3 — 1 ♂, 4 ♀♀; 3/1 — 1 ♀; 3/2 — 1 copepodite; 3/3 — 4 ♀♀; 4/3 — 2 ♀♀.

ASSOCIATED FAUNA

The interstitial fauna of the area studied is rich and varied. In addition to the copepods, representatives of the following groups were found: Protozoa, Hydrozoa, Acoela, Rhabdocoela, Nematoda, Nemertini, Gastrotricha, Archiannelida, Polychaeta, Oligochaeta, Ostracoda, Amphipoda, Collembola, Acari. Most of these were not identified. Protozoa, nematodes, polychaetes and oligochaetes were always abundant. Nemertines and gastrotrichs were relatively rare and scattered. Mites and collembolans, the latter mostly *Anurida maritima* Laboulbène, were only abundant in regions where there was an accumulation of weed debris. The only amphipod found was a single specimen of *Talitrus saltator* (Montagu) on the strand line at Bar Point, St. Mary's. Ostracoda were frequent on all shores, particularly about the low tide level.

Of the Archiannelida, one specimen of *Nerilla* sp. was found on St. Agnes (Station 4/5), the remainder being immature and adult forms of *Protodrilus flavocapitatus* (Uljanin) which was frequent on all shores, but always confined to the lower shore.

Post-larval polychaetes were abundant on all shores. A few adults or near-adults of *Scolecolepis fuliginosa* (Claparède) on St. Mary's (Station 1/2) and St. Agnes (Station 4/2) and *Phyllodoce maculata* (L.) on St. Agnes (Station 4/2) were found. One specimen of an immature *Syllis* sp. was found on Tresco (Station 2/1).

The most interesting find was that of small numbers of *Halammohydra* sp. (Coelenterata Hydrozoa Narcomedusae). It was not possible to determine the species of these owing to the method of post-sampling treatment (see Harvey & Wells, 1961). The genus has not hitherto been recorded in Britain.

ZUSAMMENFASSUNG

In Sandproben aus den Gezeitenzone von Stranden der Scilly Inseln wurden insgesamt 53 Copepodenarten nachgewiesen. Eine neue Art, eine neue Unterart und die vorher unbekannten Männchen von 4 Arten werden beschrieben. Von den gefundenen Arten waren 16 bisher noch nicht aus Gross-Britannien gemeldet worden. Über die interstitielle Begleitfauna wird kurz berichtet.

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VARIATION AND SYSTEMATIC PROBLEMS IN A GROUP OF LERNAEID COPEPODS

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THE PROBLEM

Parasitic copepods of the genus *Lernaea* are found on freshwater fishes in all continents of the world. This distribution, which is wider than that of any of the various genera of fishes which they parasitise, speaks of the antiquity of the genus.

Of rather more than thirty valid species so far described the first to achieve this distinction was *L. cyprinacea* described by Linnaeus in 1758 (but referred to in the literature before the introduction of binominal nomenclature). Linnaeus' specimens were obtained from Sweden and since that time many others closely approximating to these have been observed in Europe (see Harding, 1950, for references). More recently a number of forms similar in many respects to the European form have been described from the Far East. One of these, described as *L. elegans* by Leigh-Sharpe (1925), has usually been regarded as a synonym of *L. cyprinacea.* This form and three others (one originally described as a separate species), have been assigned sub-specific rank by Hu (1948).

In Africa *L. barnimiana* (Hartmann) is now known from several widely separated localities and is apparently widespread in the continent. This species is very similar in many respects to *L. cyprinacea,* so much so that, as shown in the following account, its separation from the latter sometimes presents difficulties.

Recently a form of *Lernaea* has been found in Lake Victoria (East Africa) which, although similar to *L. barnimiana*, which occurs in the same lake, differs from it both in morphology and in host selection and bears many similarities to some of the forms of *L. cyprinacea*, a species hitherto unrecorded from Africa if one discounts the completely worthless record of Sklower (1951). Both this form and *L. barnimiana,* with which it co-exists, are extremely variable, and so apparently is the Eurasian form of *L. cyprinacea.*

An assessment of the status and relationships of these various forms with particular reference to the newly discovered form from Lake Victoria constitutes the purpose of this paper.

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CHARACTERISTICS OF SYSTEMATIC VALUE

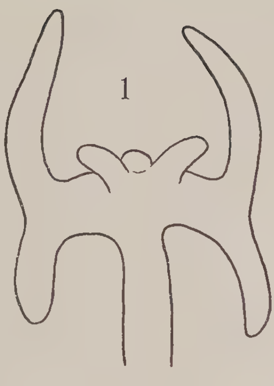
Although, as demonstrated below, anchor form in the parasites dealt with here is extremely variable, I am in agreement with Harding (1950) who regarded the shape of the anchor as the most useful systematic character. The form of the pregenital prominence is, in this particular section of the genus at least, of little or no value, for two or more specimens from the same host fish may have either a simple pregenital prominence, one which is shallowly cleft, or one which is double and very deeply cleft. This is the case for example in four individuals taken from two specimens of the cyprinid fish *Varicorhinus damascinus* (Cuvier & Valenciennes) from a Palestinian stream. All these were obviously conspecific yet all the above conditions were represented. Often a large number of specimens from a single host species and locality may have one type of pregenital prominence but occasional individuals, obviously of the same species when judged by other criteria, may have a quite different type, thus indicating the unreliability of this character. As Harding has noted, appendages are so much alike in practically all species that they are of little value in specific recognition. Hu (1948), however, records one difference in the form of the antennule and antenna of a member of this complex which is mentioned below. Torsion is also of no importance, nor can I assign any significance to the relative position of the legs, although Hu used this characteristic as a basis of sub-specific differentiation. One is, therefore, left with anchor form and internal anatomy including chromosomal number as a means of identification. The latter possibility has not yet been exploited. Preliminary tests on living material from Lake Victoria failed to reveal the chromosomes.

THE HOSTS OF *Lernaea barnimiana*

Host specificity is not very rigorous in *L. barnimiana* though the number of recorded hosts is somewhat limited. Cyprinid fishes of the genera *Barbus* and *Labeo* and cichlids of the genus *Tilapia* are the most usual but not the only recorded hosts.

One peculiar feature of the occurrence of this species is that in some areas, such as Lake Edward, it parasitizes equally freely both *Barbus* and *Tilapia,* while in Lake Victoria it is not uncommon on *Barbus* but is extremely rare on *Tilapia.* In view of the fact that it parasitizes members of different families it appears unlikely that specific differences between the species of *Tilapia* in these two lakes are of any great significance in influencing successful settlement unless it be that incipient race formation is taking place.

Fig. 1-9. Variation in anchor form in *Lernaea barnimiana* (Hartmann). 1, 2, usual anchor form of specimens settled on the flanks of the host; 1, from *Barbus zambezensis* (Peters), Bembezi River; 2, from *Tilapia nilotica* (L.), Lake Edward; 3, copepodid settled on flanks (diagrammatic); 4, copepodid settled on roof of mouth which is shown in section (diagrammatic); 5, adult in situ on flank (diagrammatic); 6, influence of palate on growth of anchor (diagrammatic); 7, 8, specimens from mouth of *Barbus altianalis* Boulenger, Victoria Nile (ventral view); 9, anterior aspect of anchor of specimen from *B. altianalis,* Victoria Nile. ABD, anterior branch of dorsal arm; B, basal portion of dorsal arm of anchor; P, bony palate; PBD, posterior branch of dorsal arm; S, scale; ST, soft superficial tissues of palate; VA, ventral arm.



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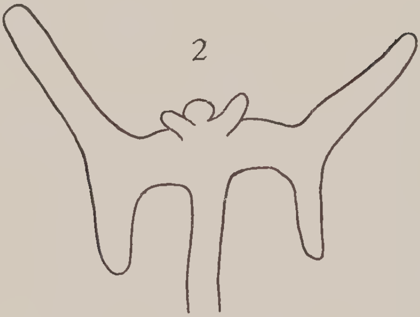

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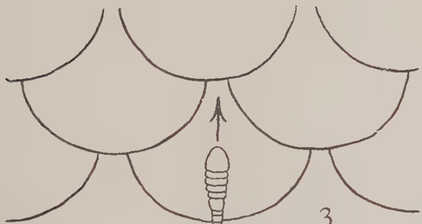

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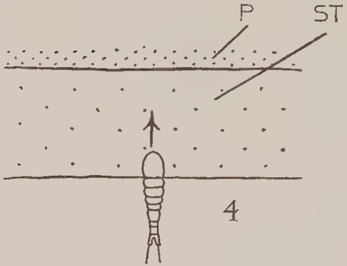

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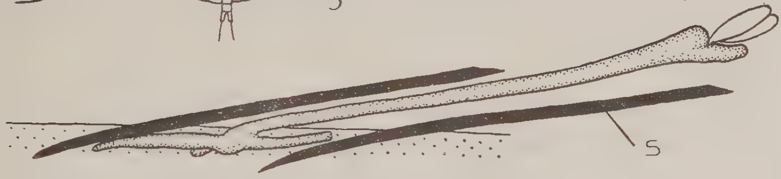

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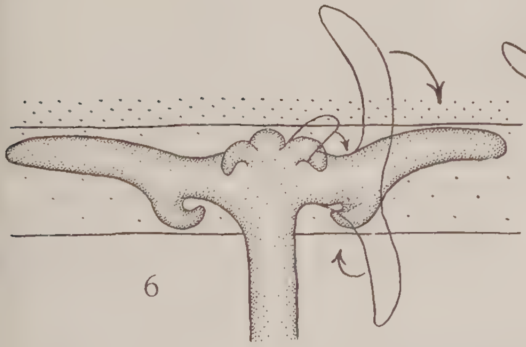

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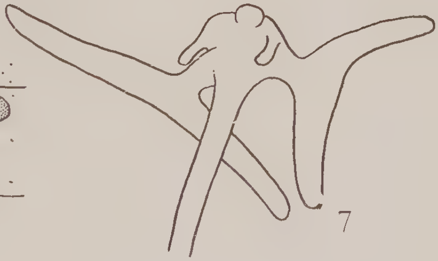

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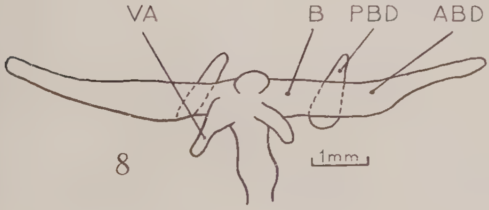
VA
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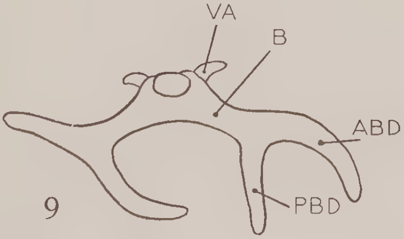

9

FACTORS AFFECTING ANCHOR FORM IN *L. barnimiana*

Let it be assumed for a moment that *L. barnimiana* is distinct from *L. cyprinacea.* This enables a large amount of African material to be considered and to ignore for the moment all non-African forms. The form of the anchor in this species is extremely variable but the factors responsible for this variation can in large measure be explained. Figs. 1 and 2 show the most usual type of anchor found in specimens attached to the flanks of *Barbus, Labeo* and *Tilapia.* The identity of the host is apparently of little or no significance in determining anchor form in specimens which establish themselves on the flanks of fishes. When a copepodid settles in this position the obvious direction of growth is initially forwards beneath a scale (fig. 3). Growth perpendicular to the flank is impossible. Once established, the anchor arms will obviously be able to grow much more easily in a plane parallel to the surface of the fish than in any other direction as they are effectively sandwiched between adjacent scales (fig. 5). Examination of fishes reveals that there can be very little resistance to growth in any direction in this plane. This explains the extreme dorso-ventral flattening of the anchor of such specimens. The branches of the dorsal arms do in fact grow in a predominantly anterior-posterior direction (fig. 1) and usually diverge from it only slightly (fig. 2). There are no mechanical reasons why these branches should not grow in other directions within this plane and the reason why they do not in fact do so is presumably genetical.

Copepodids settling on the roof of the mouth face an entirely different set of environmental circumstances. Having effected attachment they are not obliged to grow in a plane parallel to the host surface as are copepodids settling on the flanks but can, initially, grow directly into the host tissues (fig. 4). However, irrespective of the angle of entry, subsequent growth is profoundly modified by the bony palate. Initial growth of the basal portions of the dorsal arms can take place uninterruptedly but the growth of the branches is much affected. If the anterior branch attempted to grow forwards to give a structure like that shown in fig. 1, it would be unable to penetrate the bony palate and would be deflected outwards (fig. 6). If the posterior branch grew posteriorly it would re-emerge from the host tissue as shown diagrammatically in fig. 6, so it too bends through about 90° and grows in a direction parallel to the bony palate. However, while the anterior branch is deflected laterally the posterior branch is deflected dorsally, the result being that both branches grow parallel to the palate but at an angle, which often approximates to a right angle, to each other. By this means the anterior branch becomes essentially an extension of the basal portion of the arm. In a precisely similar manner the ventral arms tend to grow in different planes in the flank-settled and palate-settled individuals. The ultimate result is shown in fig. 8 which is typical of anchors from the roof of the mouth of *Barbus* of which some hundreds have been examined. Fig. 9 shows an anterior view of a rather similar anchor with all the branches essentially in one plane (but more or less at right angles to the plane of anchors from specimens settled on the flanks) while fig. 7 reveals the route by which this form was derived. Such forms as the last, which is also from the roof of the mouth of *Barbus*, are presumably able to develop in areas such as the lateral margins of the palate where there are thicker layers of flesh than near the middle.

These various anchor forms, though they differ very markedly (and their differences in form exceed the interspecific differences between certain other species) are without doubt produced by a single species in response to conditions imposed by different environments. The different forms are in fact just as worthy of the term "ecotypes" as are for example the "normal" and "rosette" forms of certain plants produced by development at low and high altitudes respectively.

Because settlement can take place in areas other than the roof of the mouth and on the flanks, e.g. near the bases of the fins, or on the wall of the gill chambers, where yet other conditions prevail, it is not surprising that a continuous series of intergrading forms from one extreme type to the other exists and that occasional specimens with abnormal anchors should be found. One such 'abnormality' which is occasionally, though rarely, seen is one in which the ventral arms, instead of being short as is typical in this species, are long as in *L. cyprinacea.* A specimen of this type taken from *Barbus* in Lake Victoria is shown in fig. 30 and another specimen from *Tilapia variabilis* Boulenger which is discussed below, is shown in fig. 31.

VARIATION IN *L. cyprinacea*: DATA FROM PALESTINE

On a priori grounds one might expect variations parallel to those studied in *L. barnimiana* to occur also in *L. cyprinacea* which is very similar in structure and has similar habits. This species is indeed very variable as can be seen from the illustrations given by Monod (1932), Gurney (1933), Yamaguti (1939), and Harding (1950). Some of this variation appears to be geographical, and specimens from the Far East tend to have shorter anchor arms than do the European forms. This is not unexpected. However, even within a restricted area the anchor form is very variable. Because of this and because the small number of specimens available to him happened to come from different hosts, Hu (1948), while rightly regarding *L. elegans* Leigh-Sharpe and *L. brachycera* (Yü) as members of the *cyprinacea* complex, gave sub-specific rank to these and two other forms from China. The validity of these is discussed below, but it may be noted that the variation shown by the anchor of all these subspecies is certainly less than that shown by specimens of *L. barnimiana* occurring on a single host species. It is also less than that shown by a form from one restricted locality (Lake Victoria) — and in fact from only a restricted part of that lake — which occurs predominantly in a specific location on, for practical purposes, only two closely related species of the same genus. Similar wide variation of anchor form within a given species has also been described by Gnanamuthu (1951) in *L. chakoensis* Gnanamuthu.

Some data from Palestine are relevant in this connection. Among numerous specimens examined from this area, four specimens taken from the indigenous

Varicorhinus damascinus (Cuvier & Valenciennes) collected in a stream in the Jordan drainage are undoubtedly assignable to *L. cyprinacea* (fig. 10) and extend its known range into the Middle East.

Many other specimens from fishponds have been collected by Dr. A. Yashouv

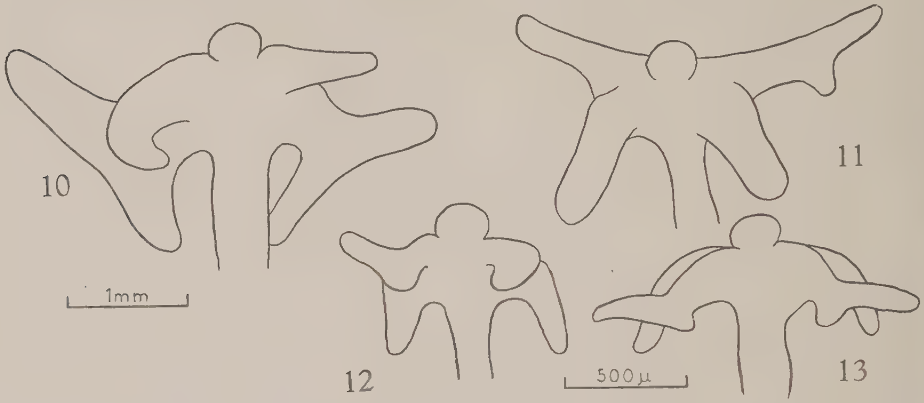

Fig. 10-13. *Lernaea cyprinacea* (L.) from Palestine. 10, from *Varicorhinus damascinus* (Cuvier & Valenciennes), a wild fish, Jordan Valley; 11-13, from *Gambusia* spec., fish ponds.

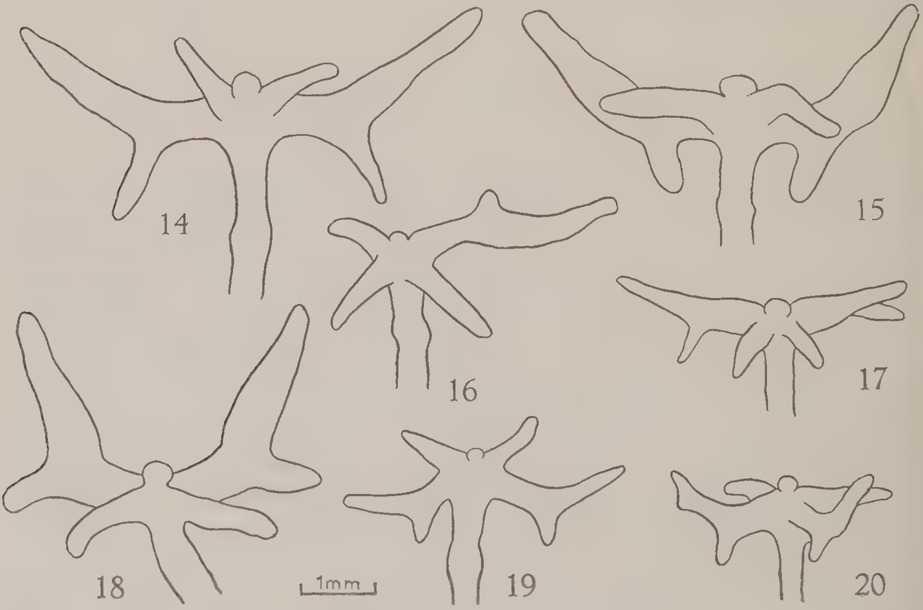

Fig. 14-20. *Lernaea cyprinacea* (L.) from Palestinian fishponds. 14, 17, 19, 20, from *Ictiobius* spec.; 15, 16, 18, from *Cyprinus* spec.; 16, abnormal specimen.

and these show very great variability, some of it apparently associated with the identity of the host. Yashouv has obtained larvae from adults settled on one host and with these has successfully infected other hosts which cover so wide a range as *Cyprinus, Tilapia, Gambusia, Mugilcephalus* and even tadpoles (Yashouv, 1959). Most of the specimens which I have been able to examine from Carp and the Buffalo-fish (*Ictiobius*) were assignable to *L. cyprinacea* (figs. 14-20), but specimens from *Gambusia* were quite different and, before I knew of Dr. Yashouv's experiments, I imagined them to belong to a new species. It is now apparent, however, that, on very small hosts such as this where the anchor has only a limited volume of tissue in which it can grow, anchor size is reduced and branching of the dorsal anchors tends to be suppressed (figs. 11-13). The form of the abdomen of the specimens parasitising *Gambusia* was also rather different from that usually encountered in *L. cyprinacea,* being consistently square cut at the tip. This I have, however, seen, though rarely, among the jaw-frequenting form from Lake Victoria (see below).

Among the specimens from larger hosts which had more typical anchors was one from *Ictiobius* which had short ventral arms more in keeping with what is typical of *L. barnimiana* (fig. 32). Such specimens as this and the long-armed individuals of *L. barnimiana* mentioned on p. 279 render the diagnosis of the species concerned very difficult.

THE JAW FREQUENTING *Lernaea* FROM *Tilapia* IN LAKE VICTORIA AND ITS DISTINCTNESS FROM *L. barnimiana*

In Lake Victoria (E. Africa), in which *L. barnimiana* is found, there occurs commonly on *Tilapia esculenta* Graham and *T. variabilis* Boulenger, and rarely on other cichlid fishes, a *Lernaea* which differs anatomically from *L. barnimiana* and which shows many similarities to *L. cyprinacea.* This parasite is very discriminating in the site which it selects for settlement and is almost invariably found on or near the jaws. Here infestations of up to 66 specimens have been found on a single fish. The anchor is exceedingly variable as can be seen from figs. 21-29 which portray a selection of these structures. In spite of this great variation familiarity with the material enables one to recognise these anchors as being distinct from those of *L. barnimiana* (compare with figs. 1-2 and 7-9). In addition specimens of this jaw-frequenting form are constantly smaller than specimens of *L. barnimiana.* Their length is usually within the range of 5.8 to 8.2 mm, while specimens of *L. barnimiana* from the same lake and from the adjoining Victoria Nile are usually between 8.5 and 13.5 mm in length.

Further, though not absolutely conclusive, corroborative evidence of the distinctness of these two forms has been obtained from a study of the life cycle. Copepodid larvae of the jaw-frequenting form have been found to occur in abundance on the gills of *Bagrus docmak* (Forskål) and from these, *Tilapia* species (including *T. zillii* (Gervais), a species recently introduced into the lake and which has not yet been found bearing these parasites in nature) have been successfully infected. Attempts at similarly infecting *Barbus altianalis radcliffi* Boulenger, the most common host of *L. barnimiana* in the lake, have so far proved unsuccessful.

Most of the evidence so far accumulated indicates that the configuration of the anchor in this form is not due entirely to its location on the host. Thus occasional specimens which have been found attached not to the jaws but to the flanks, the belly, and the fleshy parts of the buccal cavity of specimens of *Tilapia* spp., and very occasionally *Haplochromis* spp., are of similar size and have similar anchors to those attached to the jaws of *Tilapia*. These can be separated at a glance from the very few specimens of *L. barnimiana* — usually recognisable immediately from size and form — found on the flanks of *Tilapia* spp. in Lake Victoria. The reason why the anchor of the jaw-frequenting form is less influenced by conditions at the site of attachment than is that of *L. barnimiana* (at least in so far as the development of flank and mouth forms is concerned) is probably in part because it is very much smaller and can therefore develop in much more restricted spaces than that of *L. barnimiana*.

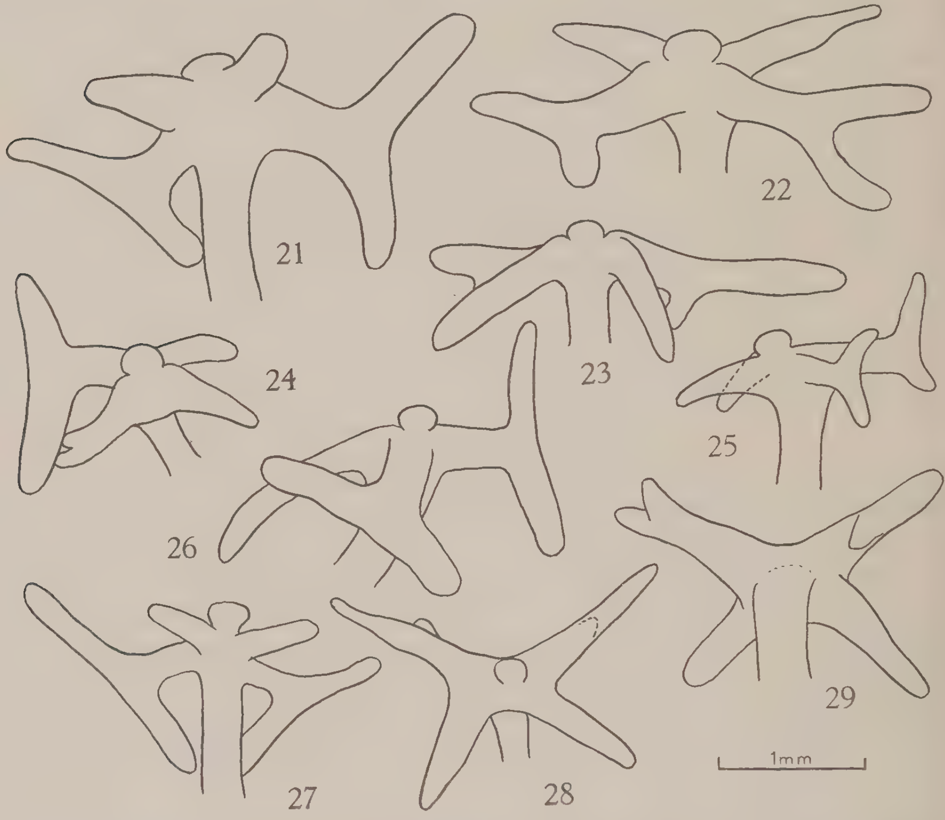

Fig. 21-29. *Lernaea cyprinacea* (L.) from the jaws of *Tilapia* spp., Lake Victoria. 24, abnormal specimen.

As noted above, specimens of *L. barnimiana* are occasionally seen on cichlid fishes in Lake Victoria, though much less frequently than in the Edward-George basin. These can usually be separated from the jaw-frequenting form without difficulty. One specimen which I assign to *L. barnimiana* was, however, anomalous. This occurred inside the tooth band of a specimen of *T. variabilis* and had an anchor very similar in size and form to that described for specimens of *L. barnimiana* occurring in the mouth of *Barbus,* but its ventral arms instead of being short as is typical of this species were very long (fig. 31), longer in fact than is usual in *L. cyprinacea.*

From these data I can only conclude that the jaw-frequenting form in Lake Victoria is distinct from *L. barnimiana.*

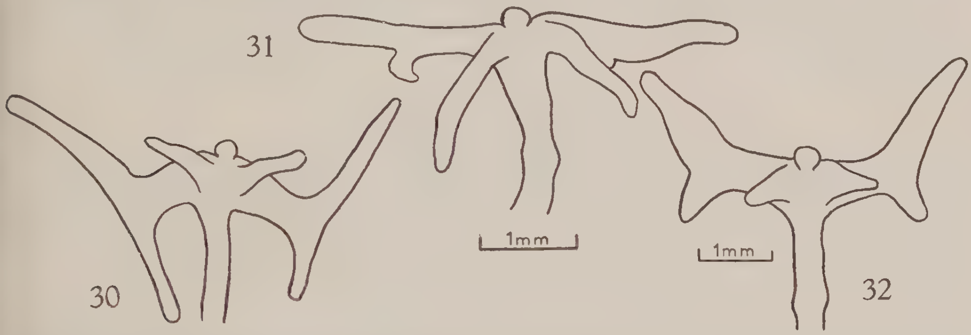

Fig. 30-32. Deceptive variants of *Lernaea* spp. 30, L. *barnimiana* (Hartmann) with long ventral arms, from flanks of *Barbus altianalis* Boulenger, Lake Victoria; 31, *L. barnimiana* with exceptionally long ventral arms, from mouth of *Tilapia variabilis* Günther, Lake Victoria; 32, *L. cyprinacea* (L.) with short ventral arms, from *Ictiobius* spec., Palestinian fishpond.

THE RELATIONSHIP OF THE JAW-FREQUENTING FORM TO *L. cyprinacea*

There is no doubt that the jaw-frequenting form of *Lernaea* from Lake Victoria is very similar to some of the described forms of *L. cyprinacea.* In fact all the types of anchor found in the Far Eastern forms of *L. cyprinacea* illustrated by Hu (1948) are embraced by the material found on *Tilapia* spp. in Lake Victoria. It is apparent, therefore, either that this form is part of the *L. cyprinacea* complex or, and less likely, that similar anchors have arisen more than once in the history of the genus. This being so I propose to recognise it as a form of *L. cyprinacea.* On geographical grounds the form from Lake Victoria merits subspecific status, but in spite of this and its host preference there seems to be little point in adding another name to the confusion which reigns at present and it would in fact be impossible to frame an unambiguous definition which would separate it on morphological criteria from other forms of the species.

That a form of *L. cyprinacea* should occur in Lake Victoria is not so surprising as may appear at first sight. This species has been found on a species of *Varicorhinus* in the Jordan system, a drainage area which has several genera, and even species, of fishes in common with Africa. Thus three species of *Tilapia* and one species of *Clarias* are common to both, as are the genera *Barbus, Varicorhinus, Garra* and *Haplochromis* (see Steinitz, 1954). It is not surprising, therefore, that during the period when interchange was possible between the two ichthyofaunas, parasites should also be exchanged. If we accept the identity of the jaw-frequenting form with *L. cyprinacea* all the evidence points to an invasion of Africa from Eurasia and not the reverse. If the supposition be correct, and if the original hosts were species of *Tilapia,* then a Nilotic origin may be inferred for either *T. esculenta* or *T. variabilis* or both. Both these species are endemic to Lakes Victoria and Kyoga. The habit of settling on the jaws in preference to other parts of the body presumably arose during the long period of isolation imposed on Lake Victoria during its history and is indicative of the racial distinctness of this form.

That the African form tends to be smaller than those found in Europe, China and Japan may be merely a further example of the effects of temperature on size in invertebrates.

A CURIOUS CASE OF CONVERGENCE

Anchor form in *L. barnimiana* can be definitely correlated with site of attachment. Now the form of the anchor in specimens attached to the roof of the mouth is often very much like that of the Malayan *L. piscinae* Harding, and, in view of the results obtained from the study of *L. barnimiana,* it seemed possible that this Asiatic species may be referable to the complex discussed here. However, specimens loaned to me by Dr. J. P. Harding, like the ones he described, were all located on the flanks of the host fish! The differences between the anchors of this species and of the flank-frequenting specimens of *L. barnimiana* are therefore genetical, and the similarities between them and the palate-frequenting specimens of *L. barnimiana* are the result of convergence, but apparently not of a type due to environmental influences. The reason why the anchor arms of *L. piscinae* are able to develop in the directions they do is probably because they penetrate deeper into the host tissues than does the anchor of *L. barnimiana* which, when it settles on the flanks, seems to grow essentially in the chambers provided by the overlapping scales.

GENERAL CONCLUSIONS

It is apparent that *L. cyprinacea* and *L. barnimiana* are closely related, so much so that, while populations can be assigned to one or the other species, occasional individuals defy determination on morphological grounds. In material lending itself to mensuration the differences could be expressed quantitatively, but this approach is not possible in these animals. It is indeed quite likely that the two species had a common origin.

During the history of the genus, *L. barnimiana* evolved in the isolation of Africa and is apparently confined to that continent, while *L. cyprinacea* spread throughout Eurasia and if, as Harding (1950) believes, *L. carassi* Tidd is a synonym of this species, through N. America as well. During its spread it crossed to Japan and entered peninsular India, and apparently invaded Africa, perhaps fairly recently, via the Nile Valley. Considering its vast range and the diversity of its hosts it is not surprising that it exhibits considerable variation. When on this variation is superimposed morphological variation which depends on the site of attachment, the problem of defining subspecies is almost insuperable. It is true that the European form differs fairly consistently from the form found in the Far East, but as there is a complete overlap of characteristics found in the latter and in the African form subspecific names are in general of little or no value.

One of the subspecies erected by Hu (1948), however, is perhaps valid and that is *L. c. macropodi* whose antennules and antennae are more robust than in any other described form. With the possible exception of cases of this sort there is little point in describing subspecies on the basis of differences found among small numbers of individuals from different hosts, for on such criteria the number that could be described would be almost limitless.

ACKNOWLEDGEMENTS

I should like to thank Drs. H. Steinitz and A. Yashouv for supplying the Palestinian material, and Dr. J. P. Harding for the loan of specimens of *L. piscinae* and for comments on my manuscript.

RÉSUMÉ

Les Copépodes parasites du complexe *cyprinacea-barnimiana* du genre *Lernaea* sont discutés. L'ancre de *L. barnimiana* est extrêmement variable en forme. Cette variabilité est en grande partie en corrélation avec l'emplacement de l'attache. La variabilité de l'ancre de *L. cyprinacea,* également bien marquée, présente une corrélation moindre avec l'emplacement de l'attache, peut-être parce qu'elle est plus petite que celle de *L. barnimiana.*

Une *Lernaea* qui, trouvée dans le Lac Victoria (Afrique orientale), est très étroitement liée à son hôte (deux espèces de *Tilapia*), n'est a mon avis qu'une forme de *L. cyprinacea.* C'est la première fois qu'on signale cette espèce en Afrique, et il est possible qu'elle ait envahi récemment ce continent par la voie du Nil.

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A NEW ISOPOD, *CHIRIDOTEA NIGRESCENS,* FROM CAPE COD, MASSACHUSETTS

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The genus *Chiridotea,* family Idoteidae, is composed of a small number of species which occur along the eastern coast of North America from Florida to Nova Scotia. The new species introduced here constitutes the fifth known member of this genus. Previously described species are *C. coeca* (Say, 1818), *C. tuftsi* (Stimpson, 1853), *C. almyra* Bowman (1955), and *C. arenicola* Wigley (1960). This group of isopods are bottom-dwelling forms that usually inhabit sandy sediments. They have the curious habit of burrowing horizontally just below the sediment surface. Three of the species mentioned have been reported only from strictly marine environments; the other, *C. almyra,* is a brackish water form. The new species described here is also a brackish water inhabitant.

Chiridotea nigrescens[1]) new species (figs. 1, 2, 3)

Material examined:

Old Silver Beach, town of Falmouth, Massachusetts; January 31, 1960; 1 male, body length 8.0 mm; 5 females, body lengths 7.0 to 8.0 mm (holo- and paratypes).

Old Silver Beach, town of Falmouth, Massachusetts; February 13, 1960; 4 males, body lengths 7.5 to 10.5 mm; 7 females, body lengths 4.0 to 8.5 mm (paratypes).

Sippewissett, town of Falmouth, Massachusetts; February 13, 1960; 8 males, body lengths 7.5 to 10.0 mm; 2 females, body lengths 6.5 and 7.0 mm.

Sippewissett, town of Falmouth, Massachusetts; February 20, 1960; 3 females, body lengths 6.0 to 8.0 mm.

Sippewissett, town of Falmouth, Massachusetts; May 25, 1960; 11 females, oostegites developed, body lengths 7.0 to 10.0 mm; 3 males, body lengths 7.0 to 9.0 mm.

Davisville, town of Falmouth, Massachusetts; May 29, 1960; 3 females, oostegites developed, body lengths 7.5 to 8.0 mm.

Chatham, town of Chatham, Massachusetts; February 22, 1960; 6 females, oostegites beginning to develop, body lengths 6.0 to 6.5 mm; 17 males, body lengths 6.5 to 8.5 mm.

TYPES. The holotype is an adult female 8.0 mm in length that was collected at Old Silver Beach, Massachusetts, January 31, 1960. It has been deposited in the U. S. National Museum (Catalogue No. 106382). Five paratypes, which were taken in the same collection with the holotype, have also been deposited in the U. S. National Museum (Catalogue No. 106383). Paratypes in this collection consist of 1 male and 4 females, 7.0 to 8.0 mm in length. A second sample of paratypes collected at Old Silver Beach, Massachusetts, February 13, 1960, are in possession of the Biological Laboratory, U. S. Fish and Wildlife Service, Woods Hole, Massachusetts. This lot contains 4 males 7.5 to 10.5 mm in length, and 7 females 4.0 to 8.5 mm in length.

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[1]) Meaning blackish; from the Latin nigrescere.

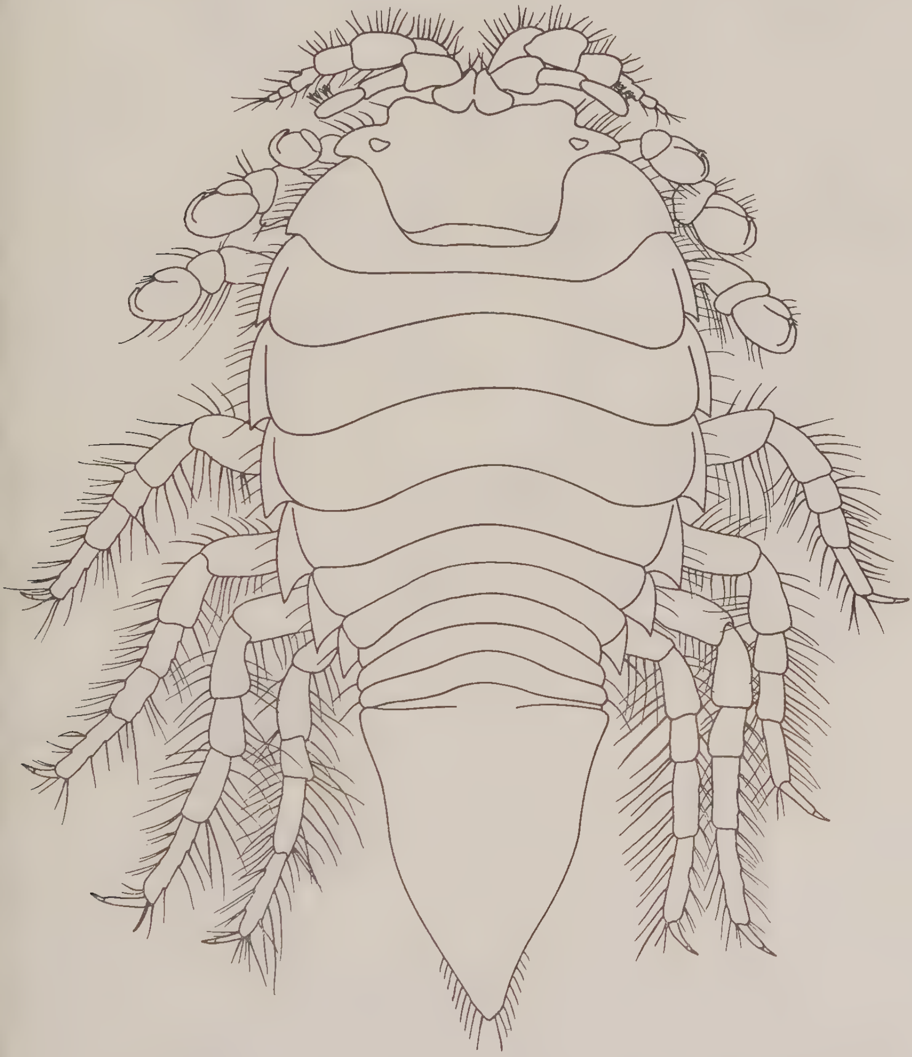

Fig. 1. *Chiridotea nigrescens* new species. Dorsal view of female holotype, body length 8.0 mm.

DIAGNOSIS. Blackish colored, medium-sized species with a broad body and both pairs of antenna short; flagellum of antenna 2 much shorter than the peduncle; antenna 1 slightly shorter than antenna 2; greatest body width one half the body length. This species most closely resembles *C. coeca* (Say), but it is clearly distinguishable by its blackish pigmentation, smaller size, shallow clefts in the anterolateral margin of the head, very sparse setation on the outer margin of the anterior lateral lobes of the head, and other characteristics described in a later section of this paper.

Description. Body ovate, twice as long as broad, and tapering to a pointed posterior. Body broadest at thoracic segment 3. Anterior margin of head with a broad, shallow excavation each side of the rostrum. Rostrum tip extends as far forward as the anterolateral projections on the head. Lateral forward projections on the head are very broad and rounded. Anterolateral margins of the head are divided into two lobes by a very shallow, U- or V-shaped notch. Margin of each anterior lobe usually bears one or two setae; posterior lobes have five to eight setae. Anterior lobes are narrower and shorter than the posterior lobes. Posterior portion of head deeply recessed in the first thoracic segment. Eyes small, irregularly oblong, located dorsally on the head at the base of the posterolateral lobes.

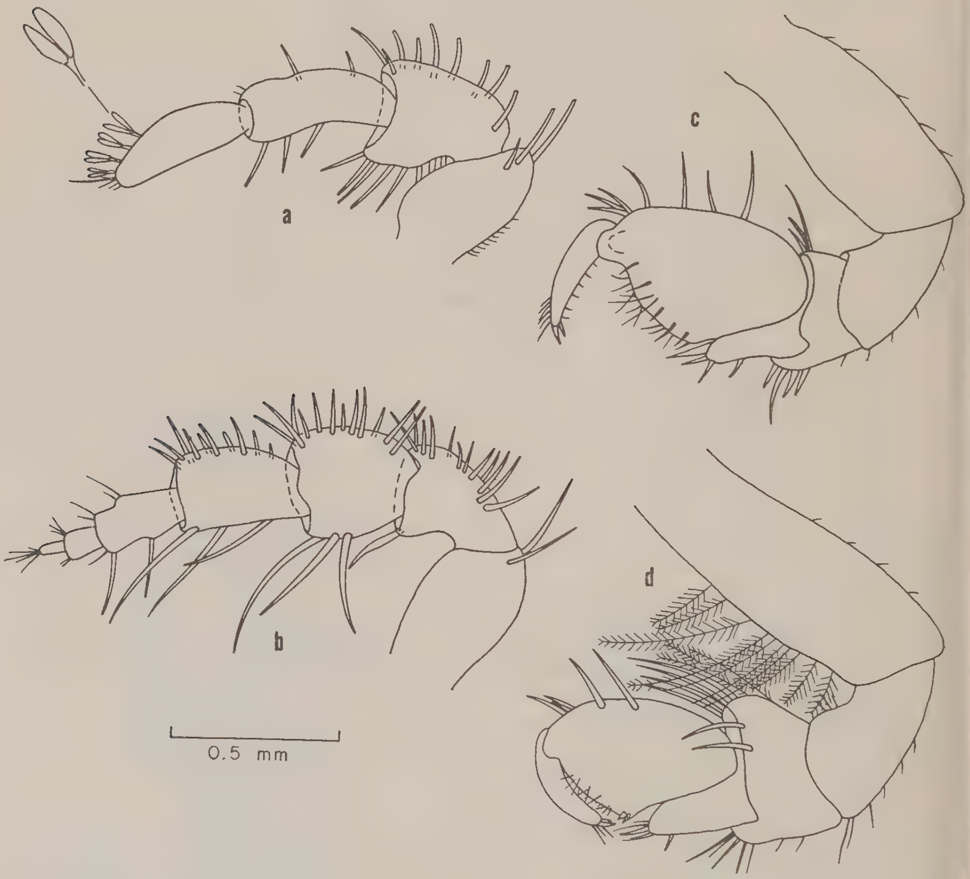

Fig. 2. *Chiridotea nigrescens* new species. a, antenna 1; b, antenna 2; c, pereiopod 1; d, pereiopod 2.

Eyes are not evident in preserved specimens (see section describing color). Epimeral plates distinct on pereion somites 2-7. Lateral margins of pereion somite 1 and epimeral plates 2-7 are slightly convex, fringed with stout setae and, except for somite 1, are acutely produced posteriorly. Pleotelson broad, composed of four

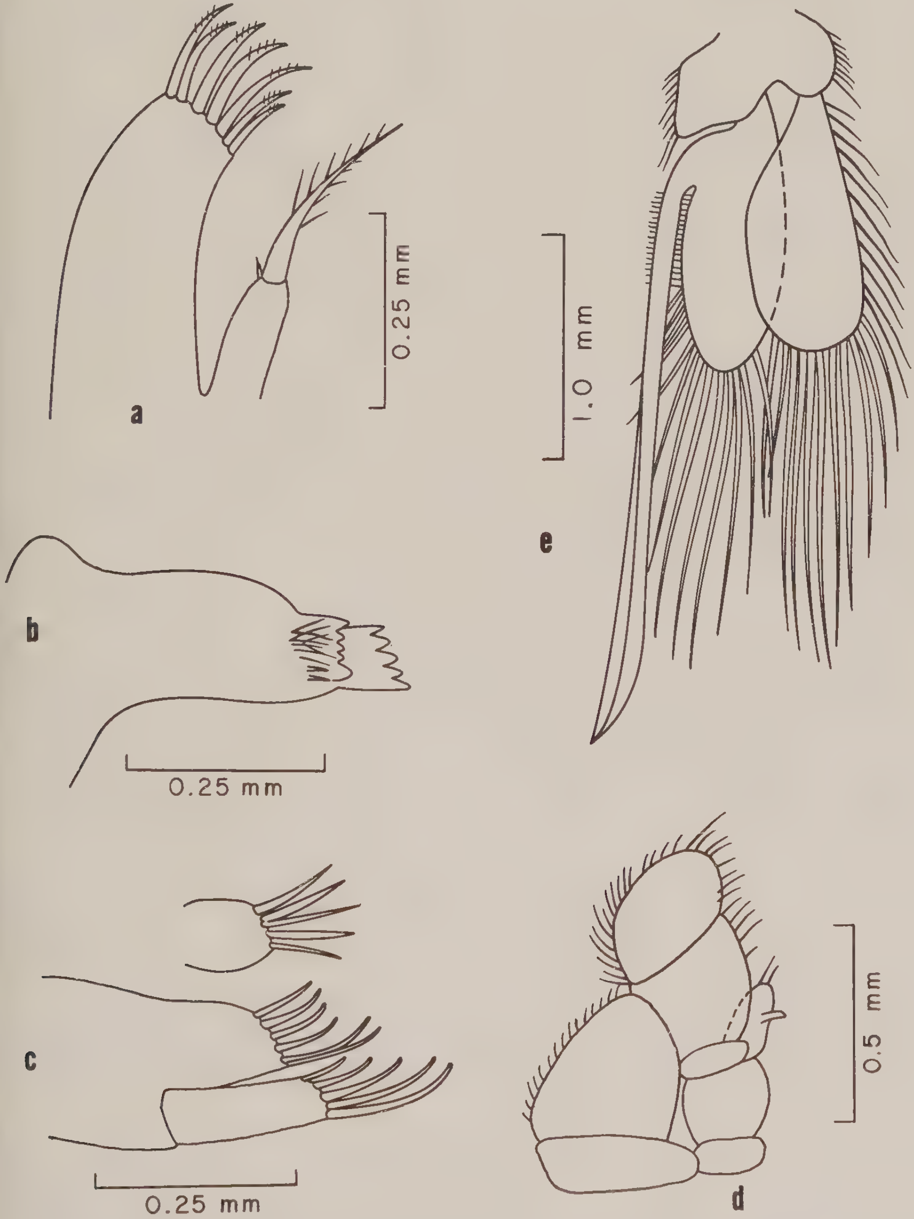

Fig. 3. *Chiridotea nigrescens* new species. a, maxilla 1; b, left mandible; c, maxilla 2; d, maxilliped; e, pleopod 2 from male paratype.

distinct segments with partial separation of another between the third and fourth segments. Lateral margins of the terminal segment taper irregularly to a pointed apex. Lateral margins near the apex are finely denticulate and the posterior 6 to 16 denticles are each furnished with a seta; distal setae are 3 to 5 times as long as the proximal setae.

Body proportions of a few significant dimensions are: body width .49 times body length; pleotelson length .46 body length; head length .16 body length; width at base of terminal segment of pleotelson .27 body length.

Both pairs of antennae short. Antenna 1 extends slightly beyond the terminal end of the peduncle of antenna 2; flagellum a single segment which has two to six pairs of inflated setae on the lower anterior face. Antenna 2 approximately 1.2 times the length of antenna 1, the flagellum is made up of three to six segments, and its length is approximately 1/3 the total antenna length. Maxilliped has a three-segmented palp. Inner lobe of maxilla 1 has two setae; one large and plumose, the other very small and uniramose. Pereiopod 1 has a propodus 1.5 times as long as broad; the occluded margin of the dactyl has about six fine setae; the oblique fringe near the inner distal end of the dactyl is composed of six to eight setae. Pereiopods 1-3 are similar in shape and structure; pereiopods 4-7 are nonchelate and are also similar to one another. The cuticle over almost the entire body and parts of exposed appendages is embellished with sculpturing. This sculpturing, made up largely of irregularly rounded discs of various sizes, is most clearly evident on the head and pleotelson.

COLOR. The body is distinctly blackish in color due to densely packed, dark chromatophores covering most body surfaces. This pigmentation is also present on many of the larger exposed appendages. Usually the chromatophores are moderately dense at the base of the appendages and diminish toward the extremity. Areas where chromatophores are lacking are cream color or whitish, depending upon tissue thickness. The pigmentation pattern from one specimen to another is quite consistent. The most darkly pigmented areas are the uropods and the mid-dorsal section of the thorax and pleotelson. Dorsal areas that are non-pigmented are: anterolateral lobes of the head, epimeral plates, and the terminal one-fourth of the pleotelson. Eyes of living specimens are silvery-white; however, when placed in preservative they soon fade. After a day or two in formalin the eyes are usually indistinguishable.

RANGE. Known only from the southern and western shores of Cape Cod, Massachusetts, U.S.A. It has been taken as far north as Old Silver Beach and as far east as Chatham. The presently known range in water temperature is 35° to 74° F.; range in water depth is ½ to 4 feet.

HABITAT. *C. nigrescens* inhabits brackish waters of tidal marshes and shallow bays, usually in the channels in clean sand sediments. Occasionally it is found in nearly fully saline water (during an incoming tide), but only near outflows of brackish water and where fresh water seepage is prevalent.

DISCUSSION. Morphologically, *C. nigrescens* is quite similar to *C. coeca*. Some of the more important species-variable features common to both forms are: short antenna 2, broad pleotelson with sides of the terminal section unevenly tapered, pereiopod 1 with a broad propodus and stout dactyl bearing a few small setae on the occluded margin. Nevertheless, these two species are clearly separable. *C. nigrescens* has the following characteristics which distinguish it from *C. coeca*: (1) It is smaller in size, ranging up to 10.5 mm in body length, whereas *C. coeca* attains lengths up to 13 mm. (2) It is dark in color, nearly black, whereas *C. coeca* is sparsely pigmented. (3) The lobes on the anterolateral margin of the head are separated by a shallow, non-setose notch, whereas *C. coeca* has a deep, setose cleft. (4) The anterior margin of the foremost lateral lobe on the head usually bears 1 or 2 setae (each side), whereas *C. coeca* frequently has between 6 to 10 setae. In addition to these differences, several other morphological factors such as the epimeral setation, globose setae on antenna 1, and the cuticular sculpturing, may also be used for separating these two species.

C. arenicola is the only other species morphologically similar to *C. nigrescens*. Some of the differentiating characteristics which are useful in separating these two species are listed here. As compared with *C. arenicola, C. nigrescens* has the following features: (1) a broader thorax and abdomen; (2) thoracic segment 1 is narrower anteriorly and has more rounded lateral margins; (3) contours of the thoracic margins are more convex, which is enhanced by the shape of thoracic segment 1; (4) pleotelson is much broader, lateral margins of the terminal segment are less evenly tapered, and the apex is more obtusely pointed; (5) pereiopods are shorter and stouter; (6) flagellum and terminal segment of the peduncle of antenna 1 are more elongate; (7) antenna 1 usually extends beyond the distal end of the peduncle of antenna 2; (8) each anterolateral lobe of the head bears 1 or 2 setae; (9) color is much darker; and (10) appendages and epimeral plates are more setose.

Ecologically, *C. nigrescens* is more closely allied to *C. almyra* than to other members of this genus. Both of these species inhabit shallow brackish waters, as opposed to the others which live in strictly marine habitats. Also, it is interesting to note that in regard to body pigmentation, these two species are densely covered with black chromatophores, in contrast to the colorless or sparse pigmentation found in the other species.

Two burrowing invertebrate animals which are frequently found in the same localities with *C. nigrescens* are the amphipod *Haustorius arenarius* (Slabber) and the polychaete *Ophelia bicornis* Savigny. I wish to thank Dr. Marian H. Pettibone, University of New Hampshire, for identifying the polychaete.

RÉSUMÉ

Description d'une nouvelle espèce d'isopode d'eau saumâtre, *Chiridotea nigrescens*. Cette espèce habite les fonds de sable pur dans les marais et les baies peu profondes le long des côtes du sud et de l'ouest du Cape Cod, Massachusetts, États-Unis. *C. nigrescens,* qui ressemble à *C. coeca* (Say), se distingue d'elle par: (1) sa couleur noirâtre, (2) sa petite taille, (3) une entaille non sétifère et peu profonde située de chaque côté de la tête, et (4) une ou deux soies au bord du lobe antéro-latéral de la tête.

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NOUVEAUX PROGRÈS DU CIRRIPÈDE AUSTRAL *ELMINIUS MODESTUS* DARWIN SUR LES CÔTES ATLANTIQUES FRANÇAISES ET IBÉRIQUES

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On sait que le Crustacé Cirripède *Elminius modestus* Darwin, originaire de la région sud-australienne et néo-zélandaise, s'est établi en Europe depuis quelques années, en deux secteurs différents, d'une part en Angleterre et rivages voisins, d'autre part, à l'angle Nord-Ouest de la Péninsule ibérique[1]).

Il a d'abord été noté sur la côte anglaise (Bishop, 1947; Crisp & Chipperfield, 1948; Stebbings, 1950: pour la mer d'Irlande, Crisp & Southward, 1959), où il a été vu pour la première fois en 1944 dans la région de Portsmouth, puis en Hollande (Leenhouts, 1947; Boschma, 1948; den Hartog, 1953) et à l'embouchure de l'Elbe (von Kühl, 1954), et aussi en France (Bishop, 1954; den Hartog, 1957; Bishop, Crisp, Fischer-Piette & Prenant, 1957; Bishop & Crisp, 1958), où Bishop l'observa pour la première fois en 1950 à Wimereux et où la dernière limite reconnue de l'extension se situait à la rivière d'Etel (entre Lorient et Quiberon); plus au Sud, il est vrai, ont été signalés trois cas de présence, mais insignifiants, un seul exemplaire ayant été vu en chacune de ces trois localités, qui sont la Pointe Saint-Jacques, le Boucau et Saint-Jean-de-Luz (Crisp, 1959).

Pour ce qui concerne la deuxième région européenne d'implantation, l'angle Nord-Ouest de la péninsule ibérique, c'est en 1956 et 1957 que les premières mentions de sa présence ont été publiées; elles rendaient compte d'une répartition à cheval sur l'Espagne et le Portugal (Fischer-Piette & Prenant, 1956 et 1957), d'après des observations faites en 1955 pour l'Espagne et en 1956 pour le Portugal. Le secteur peuplé s'étendait de Jubia en Espagne (près de Ferrol) à Aveiro au Portugal, c'est-à-dire sur 360 km environ.

Nous avons eu récemment l'occasion d'enregistrer de nouveaux progrès d'*Elminius,* d'une part le long de la côte française en direction du Sud; d'autre part, le long des côtes ibériques de part et d'autre de la région d'implantation c'est-à-dire à la fois en direction du Sud au Portugal, et en direction de l'Est sur la côte espagnole. Nous allons préciser ces données. Mais faisons déjà remarquer que les gains vers le Sud à partir de la Bretagne, et les gains vers l'Est à partir de la Galice, vont à la rencontre l'un de l'autre. Ces deux peuplements arriveront-ils à se rejoindre, cela se peut mais cela n'est pas certain; en effet, nous ne pouvons guère savoir à l'avance si *Elminius modestus,* originaire d'une région tempérée, arrivera à s'implanter dans le fond du golfe de Gascogne où le bios est d'allure assez chaude, ou bien si les deux aires resteront disjointes comme sont disjointes par exemple, de part et d'autre de ce fond de golfe, les aires de *Balanus balanoides* (L.), de *Purpura lapillus* (L.), de *Dendrodoa grossularia* (Van Beneden), de *Fucus serratus* L., de *Laminaria hyperborea* (Gunner) Foslie et de tant d'autres espèces septentrionales. Si on voit les deux peuplements finir par se rejoindre, on doit voir en même temps, nous semble-t-il, *Elminius modestus* progresser encore beaucoup vers le Sud du Portugal.

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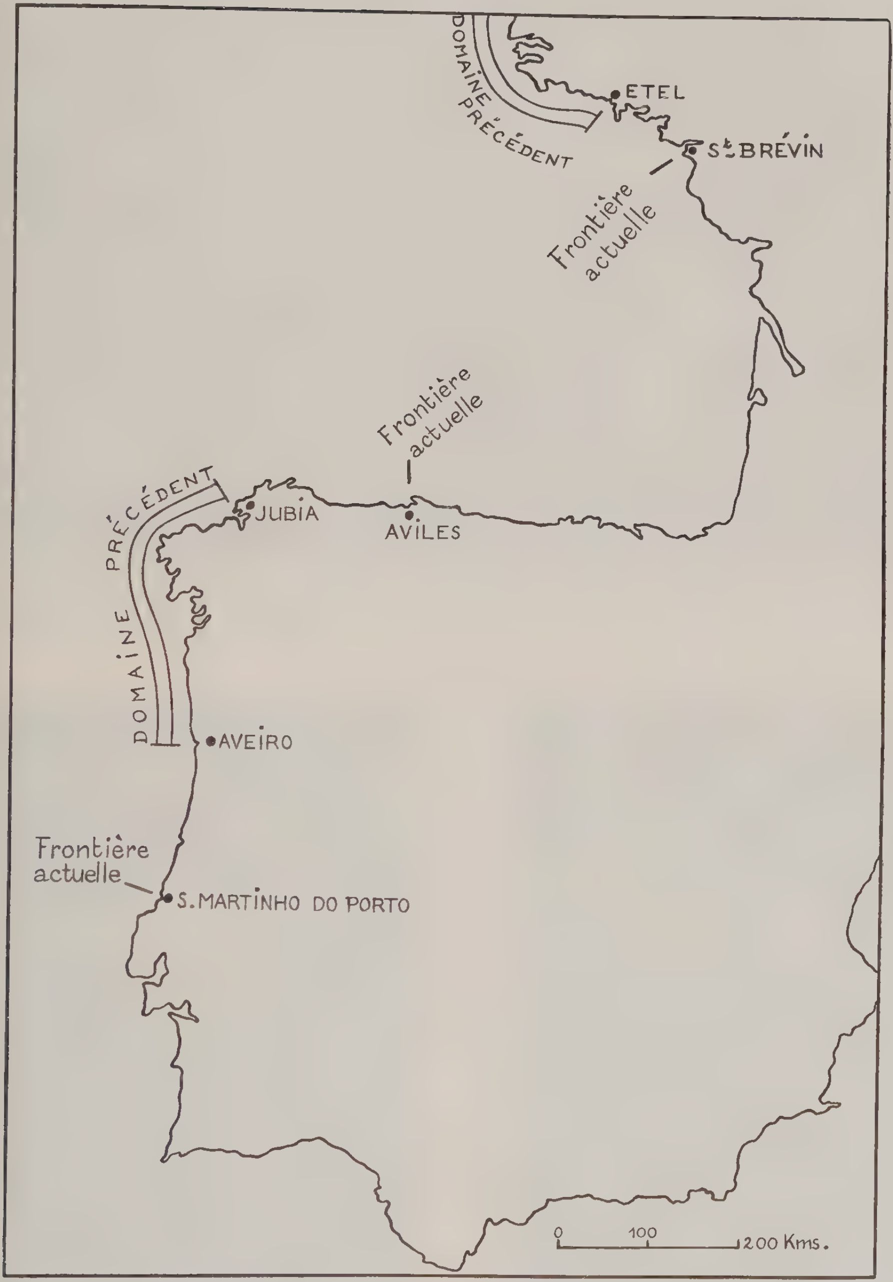
[1]) Signalons, à l'intention des collecteurs éventuels, que l'espèce présente des variations considérables dans l'aspect de la muraille. Sur chacune des quatre pièces on peut n'observer que deux larges côtes non plissées, le contour de la base dessinant ainsi une étoile à huit branches (pl. VII fig. 2) : mais le plus souvent, et en tout cas chez tous les grands spécimens, chaque côte principale est divisée par des plis secondaires et la base offre alors un contour moins régulier, avec de nombreuses indentations (pl. VII fig. 3).

On voit que la suite des évènements nous apportera divers enseignements, de sorte que nous avons l'intention d'être attentifs à les surveiller.

En attendant, voici ce qu'il en est actuellement.

Sur la côte française, en dehors des trouvailles d'un échantillon à la Pointe St. Jacques, d'un échantillon au Boucau, et d'un échantillon à St. Jean-de-Luz, la frontière Sud, en dernier lieu, se trouvait à la rivière d'Etel, où Crisp (1959) avait observé en 1957 l'espèce qui antérieurement s'arrêtait à Lorient. Or, dans une lettre du 23 décembre 1959, Mr. Marteil, Inspecteur principal des pêches à Auray, nous a fait savoir qu'il venait d'examiner les côtes entre la presqu'île de Quiberon (Morbihan) et la région de Piriac (Loire Atlantique), et y avait trouvé des *Elminius modestus* en divers points, en particulier dans toutes les rivières du golfe du Morbihan, et il nous a envoyé des échantillons de plusieurs de ces stations: Rivière de La Trinité, sur les ouvrages portuaires, les balises, etc.; St. Philibert, sur piquets; Penerf, sur la balise; embouchure de la Vilaine, sur collecteurs à Huîtres; traict de Mesquer, sur Moules de bouchots; il nous annonçait son intention d'examiner la suite de la côte, dans la région de l'embouchure de la Loire, ce qu'il a fait en 1960: il a alors constaté que l'espèce est abondante sur les rochers de la rive gauche de la Loire, près de l'embarcadère de Mindin (face à St. Nazaire), localité où nous l'avions vainement cherchée à plusieurs reprises antérieurement et en dernier lieu en mai 1958. Enfin, le 11 juillet 1960, aux bouchots situés devant St. Brevin, il a trouvé „quelques *Elminius* fixés sur les Moules attachées naturellement au sommet des pieux. Ces balanes y sont encore peu nombreuses et leur implantation y est certainement récente car j'ai eu l'occasion depuis un an d'examiner de très grandes quantités de Moules provenant de ce secteur sans y observer la présence d'*Elminius*".

De la rivière d'Etel, frontière antérieurement reconnue, à St. Brévin, le gain est de 95 km.


DOMAINE PRÉCÉDENT
ETEL
St BREVIN
Frontière actuelle
Frontière actuelle
DOMAINE PRÉCÉDENT
JUBIA
AVILES
AVEIRO
Frontière actuelle
S. MARTINHO DO PORTO
0
100
200 Kms.

Carte 1. Distribution d'*Elminius modestus* Darwin sur les côtes atlantiques françaises et ibériques.

Notons, au sujet des récoltes que nous a envoyées Mr. Marteil, que les individus de Penerf sont de très grande taille: 15 et 17 mm de grand diamètre [2]).

Plus au Sud que St. Brévin, citons, en prévision d'une extension ultérieure, les constatations d'absence faites récemment. Rappelons d'abord qu'en 1957 c'est en vain que Crisp a examiné la côte jusqu'à l'entrée de la Gironde (voir sa carte de la p. 38 du travail de 1958).

Voici une liste de localités où, plus ou moins récemment, nous avons cherché vainement les *Elminius*: Pornic (port et chenal), déc. 60; La Bernerie, oct. 59; embarcadère de Fromentine, oct. 60; Port Joinville, oct. 60; St. Gilles et Croix-de-Vie, déc. 60; Fiers d'Ars (Loix, Ile de Ré), déc. 59; Ile d'Aix, oct. 59; Fouras, id.; Le Château d'Oléron, mai 59; Le Chapus, id.; et, en juin 60, St. Palais, Royan, Talmont, phare de Cordouan et Pointe de Grave.

Faisons maintenant connaître la situation sur les côtes ibériques. A partir de l'angle N.-O. de la péninsule, considérons d'abord la situation en direction du Sud. Fischer-Piette et Prenant avaient fait antérieurement connaître (1957) que la plus méridionale des stations qu'ils avaient trouvées (en 1956) était Aveiro-Gafanha, et ils posaient la question de savoir si la propagation allait continuer vers le Sud, ou si cette espèce de régions tempérées avait atteint là sa limite définitive; question qui se posait d'autant plus, qu'en une des localités portugaises, Foz de Douro, l'espèce, présente au début de 1956, avait disparu à la fin de l'année, ce qui pouvait faire penser à une précarité de conditions due au voisinage d'une barrière climatique.

Or, des examens pratiqués depuis lors, faits en hiver 1957-58 et complétés en 1960, nous ont montré des progrès en direction du Sud.

En hiver 1957-58 l'espèce a été trouvée à Figueira da Foz, situé à 60 km au Sud d'Aveiro, et à Sao Martinho do Porto, à 75 km de Figueira et à 135 km d'Aveiro. En ces deux localités, c'est sur des emplacements où nous avions, les années précédentes, soigneusement et vainement cherché cette espèce, qu'elle a été ensuite trouvée.

De plus, dans ses autres stations portugaises, elle avait beaucoup étendu son domaine et son abondance:

Dans l'embouchure du Douro (Foz de Douro), l'espèce avait reparu, et était devenue plus abondante qu'elle n'était avant sa disparition, et elle s'étendait davantage vers l'aval.

A Leixoes, où nous ne l'avions précédemment trouvée que dans et devant le port lui-même, elle a ensuite garni tout l'immense avant-port.

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[2]) A propos des *Elminius* de France, signalons aussi la petite observation suivante que nous avons faite dans la région du Faou (Finistère) le 30 octobre 1959: en un endroit formant une légère saillie de la berge de la rive droite, à 800 m en aval du port du Faou, se trouvent des *Fucus vesiculosus* L. portant de très nombreux *Elminius modestus*, souvent serrés au point d'être jointifs (fig. 1) (il y a aussi des *Elminius* sur les pierrailles de la grève, mais plus espacés). C'est le seul endroit où nous ayons rencontré des *Elminius* sur Algues, c'est pourquoi nous croyons devoir le signaler, de la même façon que Bishop, Crisp, Fischer-Piette & Prenant avaient signalé la présence de *Balanus improvisus* Darwin sur des *Fucus serratus* L. à Talmont dans l'estuaire de la Gironde (1957: 5, 6).

A Aveiro, nous l'avions vainement cherchée dans l'embouchure de la lagune, et trouvée seulement en retrait (Gafanha-Aveiro). Depuis, elle était devenue très abondante à l'embouchure (Barra).

Signalons enfin deux stations supplémentaires dans les régions déjà antérieurement peuplées. Il s'agit, d'une part du port de La Corogne où l'espèce, vainement cherchée en 1955, était abondante en juin 1957, d'autre part de l'estuaire du rio Ave (Vila do Conde), à un emplacement non-examiné antérieurement et dont nous ignorons donc la date de peuplement [3]).

Ajoutons quelques mots à la suite d'un voyage plus récent au Portugal, en novembre 1960: de 1957-58 à 1960 il n'y a pas eu de nouvelle extension vers le Sud. Nous n'avons d'ailleurs visité en 1960 que deux de ses stations, Figueira da Foz et Sao Martinho do Porto. A Figueira elle n'avait accru, ni son domaine, ni sa densité de population. A Sao Martinho do Porto son domaine était le même, et son abondance y avait beaucoup diminué, étant tombée de 100 par m^2 à 10 par m^2.

Nous nous posons donc pour S. Martinho la question que nous nous étions posée antérieurement pour Foz de Douro: une diminution pouvant impliquer une précarité de conditions résultant du voisinage d'une barrière climatique, devons-nous penser que l'espèce a maintenant atteint sa limite Sud? L'avenir nous le dira, mais en attendant, donnons la liste des constatations d'absence faites plus au Sud.

Estuaire du Tage, tant sur la rive droite (nov. 60: à Belem; à Lisbonne sous la Praça Comercio; et sur la grève en amont du port charbonnier) que sur la rive gauche (Cacilhas, mai 58); devant le rio Sado (Torre de Outão, nov. 60) et dans le port de Setubal situé dans ce rio (id.); port de Sines (fév. 58); port de Vila Nova de Milfontes et rio Mira (mars 60); estuaire d'Odeceixe (fév. 58); rivière de Carrapateira (mars 60); port de Lagos (fév. 58); estuaire et port de Portimao (mars 60); Praia de Faro, Faro, Cabo de Santa Maria, Olhão et Vila Real de Santo Antonio (id.); enfin (janvier 61), ports de Chipiona, de Rota, de Cadiz et de Barbate (cette dernière localité au Sud du Cap Trafalgar). Nous avons l'intention de retourner ultérieurement à ces points pour voir si l'espèce continue à progresser.

Si maintenant, partant à nouveau de l'angle N.-O. de la péninsule ibérique, nous allons vers l'Est, que constatons-nous? La répartition que Fischer-Piette & Prenant avaient fait connaître en 1957 arrêtait l'espèce à Jubia. Or, en mars 1958, nous l'avons trouvée à 175 km plus à l'Est, dans la ria de Aviles, où nous ne l'avions pas rencontrée lors de nos visites antérieures qui avaient eu lieu en octobre 1949 et janvier 1955. Elle s'y trouve à Aviles même et, à quelques kilomètres plus en aval, aux abords de San Juan de Nieva (mais non dans le port même de San Juan, situé entre ce point et la mer).

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[3]) Signalons une curieuse anomalie. Dans la région déjà peuplée, un des domaines qui auraient pu sembler être les plus propices à l'établissement de l'espèce est la ria de Vigo, or les recherches y furent vaines, bien qu'il y ait là des conditions d'estuaire dans les secteurs amont, et bien qu'il y ait un très grand port (Vigo) avec un mouvement incessant de grands navires venant de partout. Comment l'espèce n'est-elle pas encore implantée dans ce domaine, alors qu'elle s'est établie dans les ports insignifiants de Vila do Conde et de Sao Martinho do Porto, où il n'y a guère que des barques de pêche? Cela est pour nous une énigme. D'ailleurs pour le port de La Corogne une remarque du même ordre est à faire aussi: les *Elminius* étaient déjà abondants dans toute la région environnante (notamment dans le rio Mero, qui n'est qu'à quelques kilomètres de La Corogne) lorsque, en 1955, le port de La Corogne en était encore dépourvu, or on aurait pu penser que ce port très important aurait dû constituer le premier point d'implantation de la région.

Entre Jubia et Aviles nous avons aussi trouvé deux stations, que nous ne pouvons d'ailleurs affirmer être très récentes car ces deux localités n'avaient pas été examinées au début. Il s'agit de Cedeira et de la ria del Barquero. A Cedeira (mai 1960) l'espèce est très localisée, sur le perré de la promenade. Dans la ria del Barquero (mai 1960), au contraire, elle s'étend sur presque toute la longueur de l'estuaire en amont de El Barquero et sous El Barquero même, localité que nous n'avons pas dépassée vers l'aval [4]).

D'Aviles à la frontière française, donnons la liste des localités apparemment favorables que nous nous sommes trouvés visiter mais où notre recherche des *Elminius* a été vaine jusqu'ici.

Port de Gijon (nov. 59); chenal de San Vicente de la Barquera (avril 60); pont de la route de la gare de S. Vicente (mai 58); San Martin dans la ria de Santander (août 60); port de Castro-Urdiales (mars 60); ria de Plencia (id.); port de Motrico (fév. 60); Deva (id.); Pedernales (août 60); ria de Pasajes (mars 59).

De ces faits nouveaux il résulte que *Elminius modestus,* qui en 1955-56 s'étendait sur un secteur des côtes ibériques long de 360 km environ, s'étend maintenant sur 660 km environ, par gains dans les deux sens (voir la carte). Rappelons que l'extension vers l'Est est en fait, tout comme celle qui se produit en direction du Sud, une extension dans un domaine où les conditions sont plus méridionales qu'elles ne sont en Galice, puisqu'on sait depuis longtemps que dans le fond du golfe de Gascogne les espèces des pays froids sont défavorisées et les espèces des pays chauds favorisées. De sorte que, ainsi que nous l'avons dit, la question se pose de savoir jusqu'où l'espèce pourra finalement s'étendre vers l'Est, tout comme elle se pose de savoir jusqu'où elle pourra finalement s'étendre vers le Sud. Il n'est nullement certain que toutes les rives du golfe de Gascogne jusqu'au fond, arrivent en définitive à être peuplées à partir de la Galice et de la Bretagne.

En résumé, la situation actuelle d'*Elminius modestus* marque, dans ces derniers temps, un gain de 95 km en allant de la Bretagne vers le Sud et, à partir de l'angle

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[4]) Notons que malgré l'existence, dans cette ria, de très copieuses populations de Fucacées (*F. ceranoides* L., *F. vesiculosus* L. etc.) nous n'avons pas trouvé un seul exemplaire d'*Elminius* fixé sur Fucacée: c'est uniquement sur les roches et pierrailles qu'on les trouve. Notons aussi que, dans toute la moitié amont du territoire où nous l'avons vue, l'espèce, bien qu'abondante, n'existe que sous les pierrailles et sous les roches en surplomb, mais non vraiment à découvert, tandis que dans la moitié aval (plus marine) elle se présente très bien à découvert. *Fucus ceranoides* est la seule espèce qui la dépasse vers l'amont, tandis que *Pelvetia, Ascophyllum, Fucus platycarpus* Thur., *Fucus vesiculosus* L., *Littorina saxatilis* (Olivi), *Littorina littorea* (L.), *Chthamalus stellatus* (Poli), etc. ne remontent pas autant qu'elle.

N.-O. de la péninsule ibérique, un gain de 175 km vers l'Est et un autre de 135 km vers le Sud. Entre les deux secteurs européens d'implantation de l'espèce subsiste, en dépit de ces progrès, une lacune considérable, qui va depuis l'embouchure de la Loire jusqu'en pleines Asturies (Aviles près Gijon).

SUMMARY

The authors follow the progress of *Elminius modestus* in the two regions of Europe in which it has become established. In the first, along the coast of France, the species has gained 95 kilometres towards the south from Etel in Brittany — the furthest limit previously recorded. In the second, along the Iberian coast, the gain is 175 kilometres towards the east from Jubia, near Ferrol, in Spain and 135 kilometres towards the south from Aveiro in Portugal. Between these two sectors there is, in spite of this progress, a considerable gap which extends from the estuary of the Loire to the neighbourhood of Gijon.

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COPEPODS ASSOCIATED WITH INDIAN MOLLUSKS

(B) DESCRIPTION OF TWO NEW *Conchyliurus* SPECIES FROM *Meretrix meretrix* (L.)

BY

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A summary on the reported species of *Conchyliurus* along with the description of *Conchyliurus maximus* is given in the first paper of this series (Reddiah, 1961). The present paper deals with the description of two other new species of the same genus, *C. bombasticus* sp. nov., and *C. fragilis* sp. nov., both occurring in the mantle cavity of *Meretrix meretrix* (L.). The new specific names refer to the condition of the male maxillipeds.

Conchyliurus bombasticus sp. nov.

MATERIAL AND TYPES. Numerous adult males and ovigerous adult females from the mantle cavity of *Meretrix meretrix* (L.) collected on the shore of the sandy mud lagoon at Puddupeta near Portonovo (Coromandel coast), South India, in February 1960. Male holotype, female allotype and paratypes (3 males and 6 females) obtained from about 10 hosts have been deposited in the British Museum (Nat. Hist.), London (reg. no. 1960 10.21. 4-6). About the same number of paratypes have been deposited in the Indian Museum, Calcutta (reg. no. C. 3884/1); U.S. National Museum, Washington, D.C. (cat. no. 106358); and in the Zoölogisch Museum, Amsterdam (cat. no. Co. 100.626).

DESCRIPTION OF THE ADULT MALE. Length of the body excluding the caudal setae 1.5 mm (range 1.3-1.6 mm) based on the measurement of 11 specimens. The body shape (fig. 1 b) is cyclopoid. The prosome equals the length of the urosome and the metasome is only slightly longer than the cephalosome. The widths of the posterior part of the cephalosome and of the succeeding pedigerous segments are about equal. Their lateral edges are angular. The rostrum is prominent and clear in both the dorsal and ventral views. A large eye spot is visible in the dorsal view.

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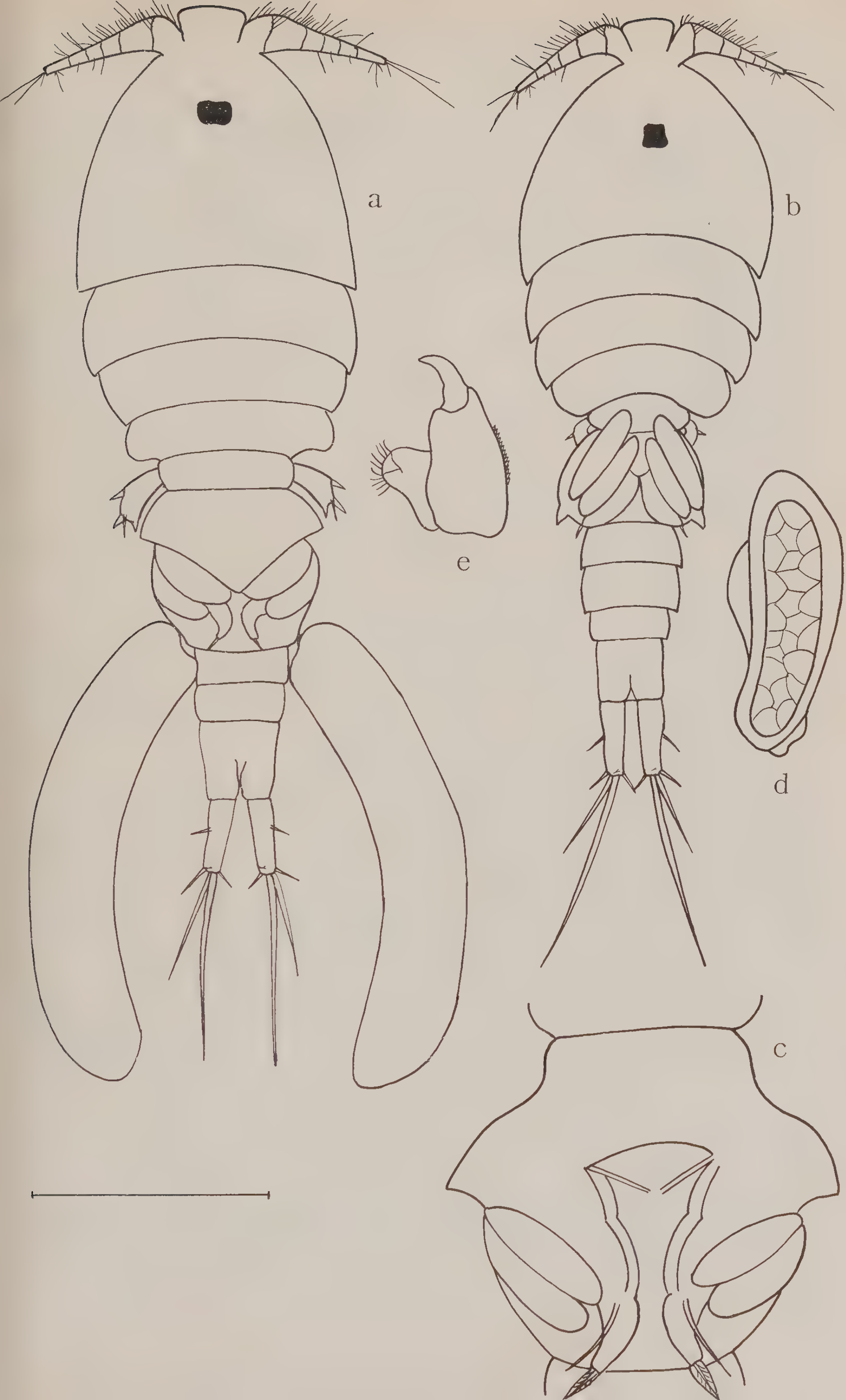
Fig. 1. *Conchyliurus bombasticus* sp. nov. Adult female: a, dorsal view; c, genital segment; e, maxilliped. Adult male: b, dorsal view; d, spermatophore. The scale represents 0.5 mm for a and b, 0.24 mm for c, d and e.


a
b
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The urosome is 6-segmented of which the genital segment is the largest. It is wider than long containing two pairs of spermatophores, each measuring about 0.25 mm. The postero-lateral corners of the genital segment bear two prominent spines. There are four postgenital segments of which the fourth is the longest and the third the shortest. The combined length of the first two segments is about equal to that of the last two. Each caudal ramus equals the length of the anal segment and bears two outer setae and four terminal setae with the proportionate lengths as shown in the figure.

The antennule (fig. 2 b) consists of six segments of which the second is the longest and the fourth the shortest. There are several setae on each segment, the sixth segment bearing 3 setae laterally and 3 terminally. The 4th, 5th and 6th segments bear aesthetasks, that of the 4th is the shortest reaching up to the tip of the 5th segment only.

The antenna (fig. 2 c) is 4-segmented. The proximal segment is the longest with an accessory structure at its base. On its outer distal border, a plumose seta and close to it a small denticle and a few fixed processes are borne. In addition, there is a row of denticles distally and a row of fixed processes on the inner lateral margin at about the middle of the segment. The second segment carries with it two rows of denticles and a seta. The third segment is small and angular. Its inner lateral margin is produced into a thickened area ending in a small spine and its outer distal border has a strong claw and a seta. There is a small bristled seta distally. The fourth segment terminally bears three strong claws, two long and one short setae. The outer distal corner of this segment is produced into a small fixed spine. The third claw (from outside) is strongly bent and recurved.

The labrum (fig. 3 c) is bilobed and has a sinuate posterior margin. The notch between the two lobes is not deep. The maxillule (fig. 2 e) is unisegmented with a broad base bearing 3 outer spines and 3 terminal spines. Of the latter, the middle one is shorter and stouter. The mandible (fig. 3 a) consists of a single segment with a short neck. Terminally it bears three spines which are finely setose. The maxilla (fig. 3 b) is 2-segmented, the first is long and unornamented while the second bears a strong and stout claw. There are two small claws on the convex side and one on the concave side of the large claw. The maxilliped (fig. 2 d) is 2-segmented, robust and powerful. The basal segment is short and unornamented. The second segment is longer, terminally ending in a strong, stout and powerful claw. There is an inwardly directed protuberance running parallel to the claw from which arise two long setae. There is another long seta on the distal outer corner of the segment. The paragnath is a lobed structure bearing a few bristles, situated between the maxillule and the maxilla. The position of the mouth parts and the post-oral protuberances are as shown in the figure (fig. 2 a).

The four swimming legs (fig. 3 d-g) each consist of a 2-segmented protopod, a 3-segmented endopod and a 3-segmented exopod of similar lengths. The distribution of articulated spines and setae is summarised in table I. The articulated spines referred to are all sheathed and the setae are all plumose except for that on

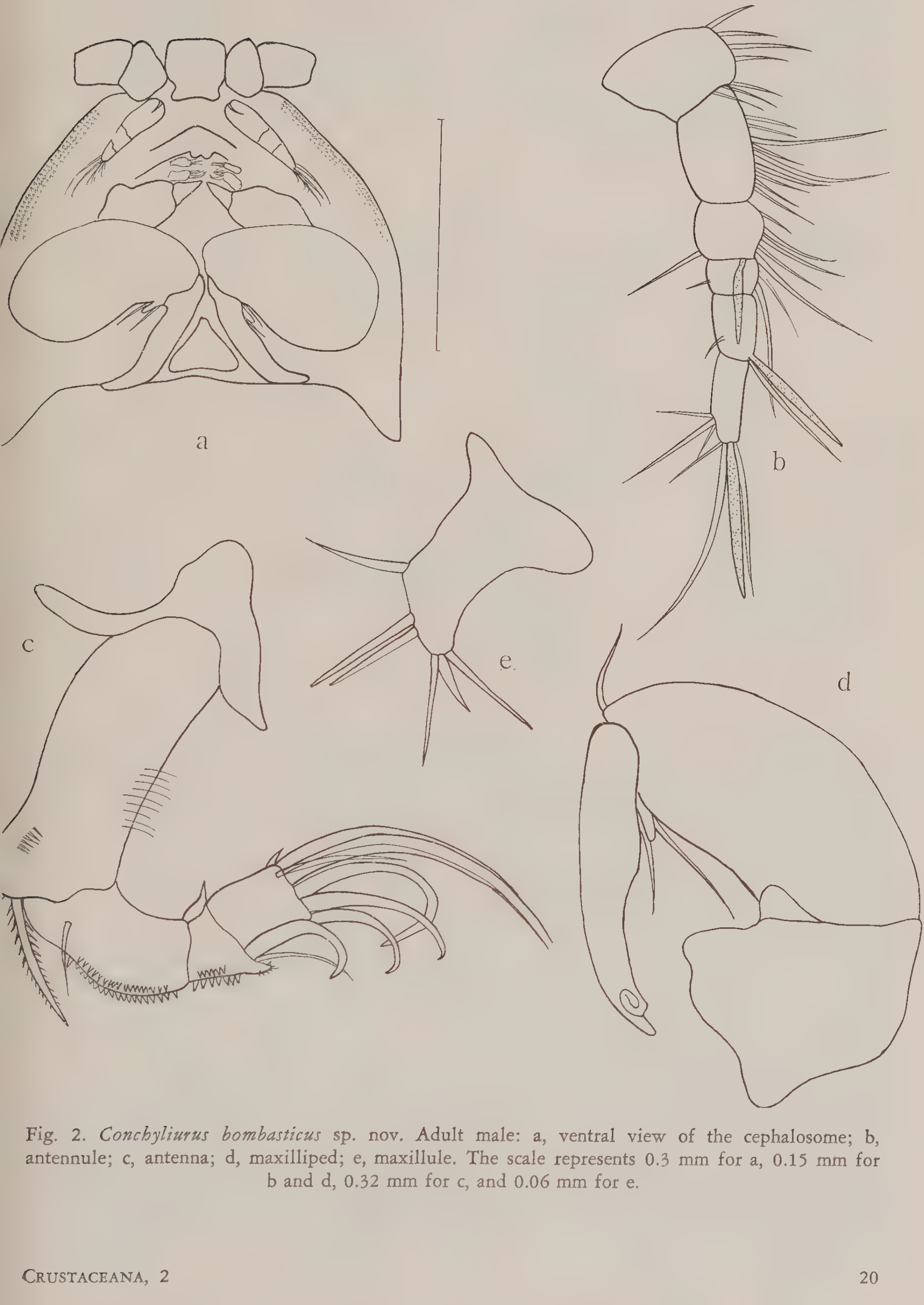


Fig. 2. *Conchyliurus bombasticus* sp. nov. Adult male: a, ventral view of the cephalosome; b, antennule; c, antenna; d, maxilliped; e, maxillule. The scale represents 0.3 mm for a, 0.15 mm for b and d, 0.32 mm for c, and 0.06 mm for e.

the outer margin of the basis of each leg. There is at least one process situated terminally on each exopod which may be regarded as a seta or a spine and is sheathed on its outer and plumose on its inner margin. These are not indicated in table I but are included as belonging to either spines or setae. In addition, there are a number of fixed processes ranging from small crenulations to conspicuous spines and also fringes of fine hairs. The first leg possesses the characteristic spine on the inner margin of the basipodite.

TABLE I

Articulated processes (spines and setae) on the swimming legs of Conchyliurus bombasticus *sp. nov. Spines are denoted by roman numerals and setae by arabic numerals. Si, St, Se: inner, terminal and outer margins of the segments. P1-P4: 1st to 4th legs.*

	Protopod				Endopod						
	1		2		1		2		3		
	Si	Se	Si	Se	Si	Se	Si	Se	Si	St	Se
P1	1	0	I	0	1	0	1	0	3	II	I
P2	I	0	0	1	1	0	2	0	2	1I	II
P3	I	0	0	1	1	0	2	0	2	II	II
P4	I	0	0	1	1	0	2	0	1	II	II

	Exopod						
	1		2		3		
	Si	Se	Si	Se	Si	St	Se
P1	0	I	1	I	3	1I	III
P2	0	I	1	I	4	1I	III
P3	0	I	1	I	4	II	III
P4	0	I	1	I	4	II	III

The fifth leg (fig. 3 h) is 2-segmented. The proximal segment bears a seta; the distal segment has two outer and one inner sheathed spines. There is another small fixed spine on the inner distal corner. A seta arises from near the outer distal sheathed spine. There is a row of spinules extending along the terminal border of the distal segment. The sixth legs (fig. 1 b) arise as prolongations from about the middle of the genital segment dorsally, bearing sheathed spines terminally.

COLOUR. Body of the live specimen colourless and the eye spot brick red.

DESCRIPTION OF THE ADULT FEMALE. The adult female (fig. 1 a) differs from the male in size, in the structure of the genital segment and maxilliped, and in the number of the post-genital segments. Length of the adult female 1.8 mm, based on the measurement of 10 specimens.

The genital segment (fig. 1 c) is slightly broader than long and has a characteristic shape. The lateral margins are produced and angular. A pair of spermatophores are attached on either side. There are three postgenital segments. The first is slightly longer than the second, while the third equals the length of the caudal ramus. The ovisacs are long and slender, extending to the tip of the longest caudal seta. The sixth legs arise as prolongations from the genital segment posteri-

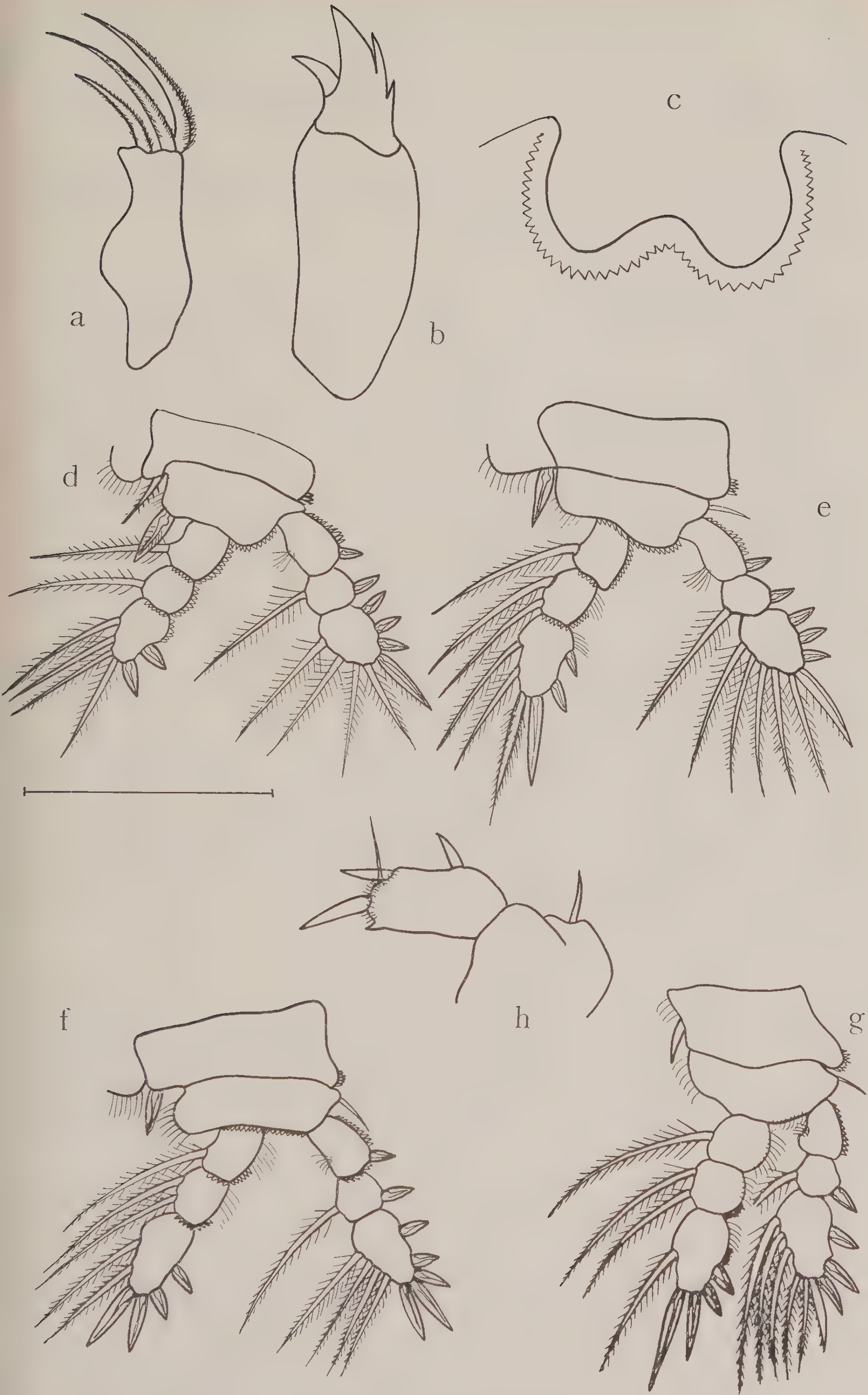


Fig. 3. *Conchyliurus bombasticus* sp. nov. Adult male: a, mandible; b, maxilla; c, labrum; d-g, 1st to 4th legs; h, 5th leg. The scale represents 0.22 mm for d to h, 0.1 mm for b, 0.05 mm for a.

orly, each having a sheathed spine. In some, a long spine is also visible arising from the base of the fifth leg. Size of the ovisac 0.8 × 0.2 mm. Each ovisac contains from 60 to 70 eggs.

The maxilliped (fig. 1 e) consists of a single segment bearing a strongly recurved claw terminally, and spinules laterally and ventrally. There is an accessory structure at its base bearing a few spinules distally.

COLOUR. As in the male.

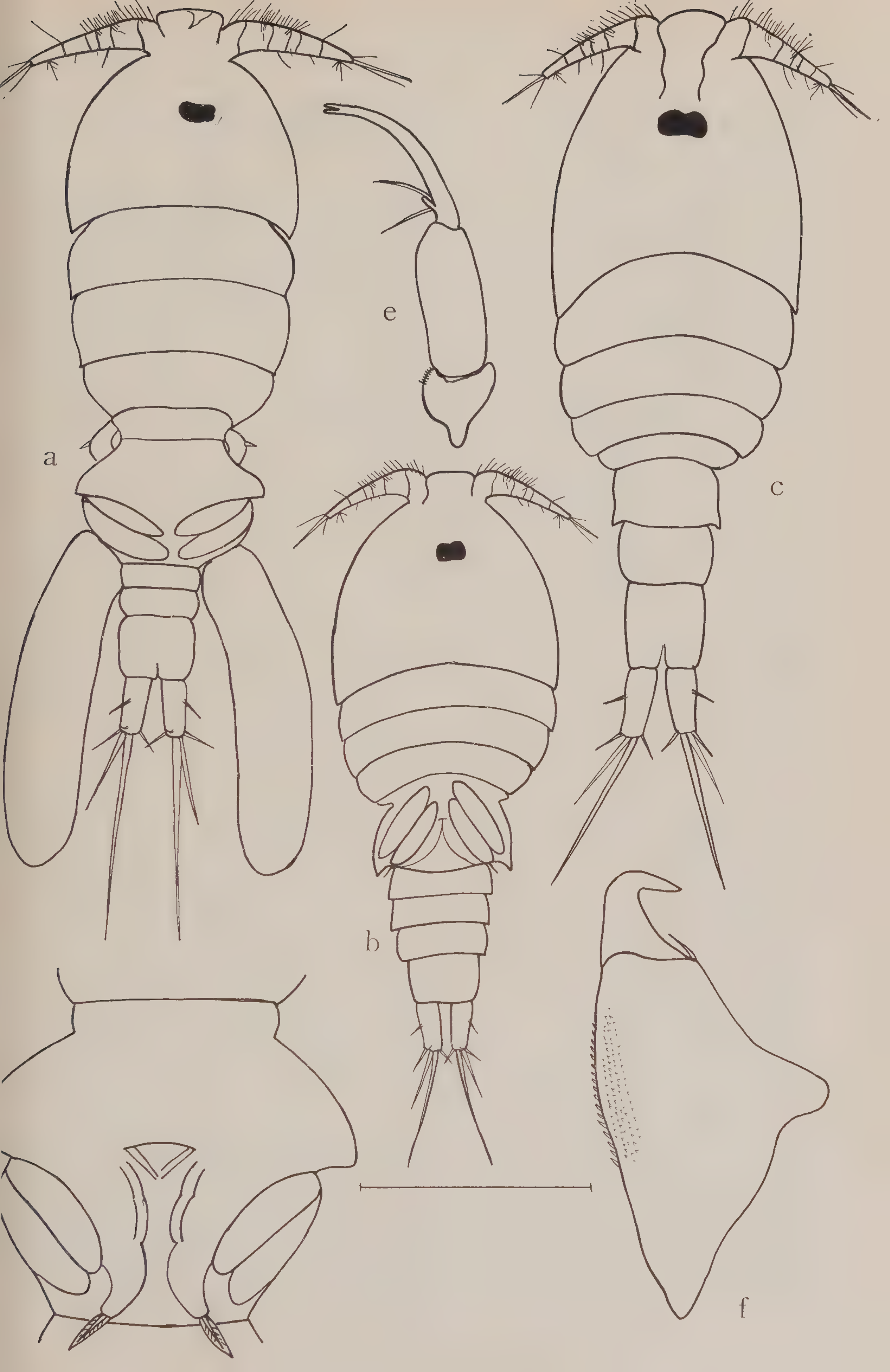
REMARKS. *C. bombasticus* differs from *C. solensis* Bocquet & Stock, 1957, in the presence of aesthetasks on the 4th, 5th, and 6th antennal segments, in the presence of a long seta on the second segment of the male maxilliped, in the structure of the male maxilliped and in the shape of the genital segment. From *C. cardii cardii* Gooding, 1957, it differs in having an aesthetask on the 4th segment (Gooding's statement (:213) of the presence of aesthetasks on 5th and 7th segments in *C. cardii* has to be corrected to 5th and 6th) and a more robust male maxilliped, in the smaller size of the female and in the shape of the female genital segment. From *C. cardii tapetis* Bocquet & Stock, 1958, the new species differs in the anal segment lacking fine hairs, in the structure of the male maxilliped and in the size of the spermatophores. From *C. torosus* Humes & Cressey, 1958, it differs in the size of the female, in the nature of the claws of the antenna, in the structure and ornamentation of the male maxilliped, in the form of the labrum, in the absence of rows of fine hairs at the junctions of the postgenital segments in males and females and in the shape of the female genital segment. From *C. lobatus* Humes & Cressey, 1958, it differs in the larger size of the female, in the form of the labrum, in the shape of the female genital segment, in the shape of the first postgenital segment in the female, in the absence of fringes of fine hairs at the junctions of the post genital segments. From *C. maximus* Reddiah, 1961, it differs in the size of both males and females, in the shape of the genital segment in both sexes, in the structure of the male maxilliped and in the ornamentation of the swimming legs.

Conchyliurus fragilis sp. nov.

MATERIAL AND TYPES. Same locality and data as in the preceding species. Holotype and paratypes (8 males and 4 females) taken from about 15 hosts have been deposited in the British Museum (Natural History), London (reg. no. 1960. 10.21.1-3). About the same number of paratypes have been deposited in the Indian Museum, Calcutta (reg. no. C. 3885/1); United States National Museum, Washington, D.C. (cat. no. 106359); and in the Zoölogisch Museum, Amsterdam (cat. no. Co. 100.625).

DESCRIPTION OF THE ADULT MALE. Total length 1.17 mm (range 1.13-1.2 mm) and width 0.33 mm based on the measurement of 12 specimens. *C. fragilis*

Fig. 4. *Conchyliurus fragilis* sp. nov. Adult female: a, dorsal view; d, genital segment. Adult male: b, dorsal view; e, maxilliped. Immature male: c, dorsal view; f, maxilliped. The scale represents 0.5 mm for a and b, 0.24 mm for c to e, and 0.05 mm for f.


a
e
c
b
f

shows many resemblances to *C. bombasticus* in the general body form, in the structure of the antennule and antenna, the mouth parts and in the ornamentation of the swimming legs.

The abdomen (fig. 4 b) is slightly more elongated and the first two postgenital segments are shorter than in *C. bombasticus.* The fixed spine on each postero-lateral corner of the genital segment is larger in *C. fragilis.* The aesthetask on the 4th segment of the antennule is the longest in *C. fragilis,* extending far beyond the last segment, while in *C. bombasticus* it is remarkably short. The aesthetask on the last segment is shorter than that of the 5th in *C. fragilis.* The first and second segments of the antennule bear more setae than in *C. bombasticus.* The first segment of the antenna (fig. 5 b) is devoid of bristles and the accessory structure on the outer lateral margin of the 3rd segment is smaller in *C. fragilis.*

The labrum (fig. 6 a) is bilobed, having a deeper notch than in *C. bombasticus.* The mandible (fig. 6 b) resembles that of *C. bombasticus* but for slight differences in the shape of the segment. The maxilla (fig. 5 c) is slightly larger than in *C. bombasticus* and has two small denticles at the distal outer corner of the segment. The maxilliped (fig. 4 e) is 2-segmented, slender and fragile. The first segment is short, bearing a few bristles on its outer free margin. The second segment is long, bearing a slender claw. There are two setae arising from the inward prominence at the proximity of the claw. The fixed spine on the outer distal margin of the 5th leg (fig. 6 d) is longer in *C. fragilis.* The four swimming legs (fig. 6 e-h) are similar to those of *C. bombasticus* and Table I is applicable to this species also. The basipodites of the swimming legs in *C. fragilis* have more prominent muscle bands. The sixth legs are similar to those of *C. bombasticus*

COLOUR. Colour of the body and of the eye spot as in *C. bombasticus.*

THE IMMATURE MALE. The immature male (fig. 4 c) differs from the adult male in the cephalosome being larger than the prosome, in the number of postgenital segments and in the structure of the maxilliped (fig. 4 f). The brick-red eye spot is slightly larger than in the adult and bilobed anteriorly. The last abdominal segment is 1½ times longer than the caudal ramus. The genital segment is short, equals the length of the succeeding segment and bears two spines at its postero-lateral corners. The endopodites and exopodites are each 2-segmented. The first leg develops the characteristic sheathed spine. The maxilliped resembles that of the adult female in having a single segment bearing a strongly bent and pointed claw. The surface of the expanded segment is ornamented with five or six rows of denticles. There is a small seta on the distal corner of the segment near the concave face of the claw.

THE ADULT FEMALE. The adult female (fig. 4 a) differs from the adult male in the body size, the structure of the genital segment, the maxilliped and in the number of the postgenital segments. Length of the body 1.6 mm (range 1.5-1.7 mm) based on 7 specimens. The body shape resembles the male; the prosome is more elongated than in the male. The genital segment (fig. 4 d) is wider than long with a pair of spermatophoral grooves on each side to lodge the spermato-

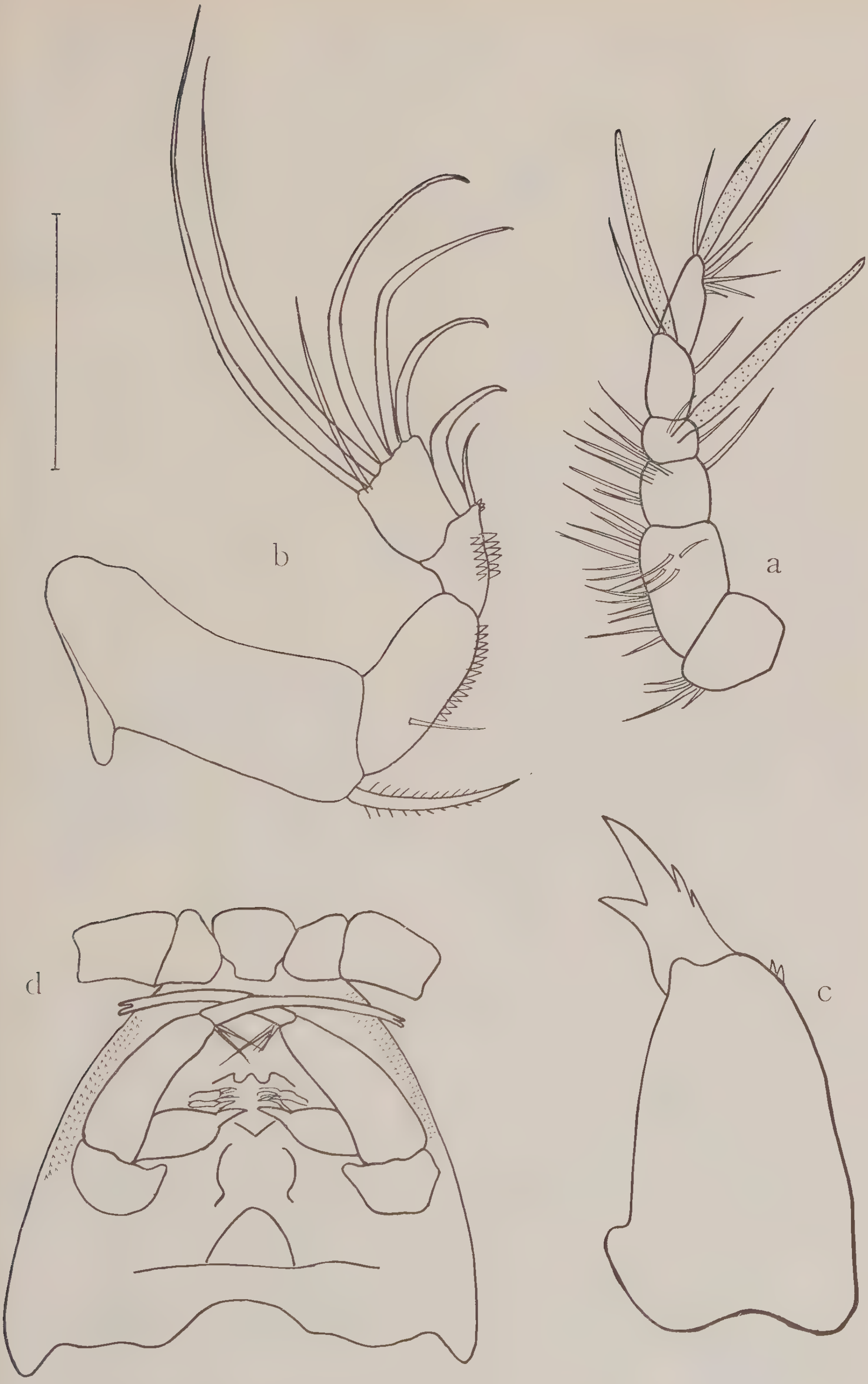


Fig. 5. *Conchyliurus fragilis* sp. nov. Adult male: a, antennule; b, antenna; c, maxilla; d, ventral view of the cephalosome. The scale represents 0.1 mm for a, 0.05 mm for b and c, and 0.24 mm for d.

phores. The sixth legs arise as prolongations from about the middle of the segment, each having a plumose seta as in *C. bombasticus.* The ovisacs measure 0.65 × 0.2 mm, each containing 35-40 eggs. The maxilliped (fig. 6 c) consists of a single segment, the lateral and ventral surfaces of which are ornamented with denticles. Terminally, there is a strongly bent claw and a prominent seta. There are three postgenital segments of which the last segment is slightly longer than the first two together. The caudal ramus and its setal arrangement are similar to those in the male.

COLOUR. Colour of the body and eye spot as in the male.

REMARKS. *C. fragilis* differs from all the other species so far described in the size of the males; from *C. solensis,* in the absence of aesthetasks on the antennule and in the structure of the genital segment; from *C. cardii cardii,* in the presence of an aesthetask on the 4th segment of the antennule, in the number of setae of the male maxilliped; from *C. cardii tapetis,* in the absence of a fringe of fine hairs on the anal segment and in the feathered condition of the innermost caudal seta; from *C. torosus,* in the lack of ornamentation on the second segment of the male maxilliped, in the form of the labrum, in the absence of fringes of fine hairs at the junctions of the postgenital segments and the structure of the claw of the male maxilliped; from *C. lobatus,* in the form of the labrum, in the structure of the genital and postgenital segments and in the absence of the fringed condition at the junctions of the postgenital segments; from *C. maximus,* in the size of both males and females, in the form of the labrum, in the presence of setae on the maxilliped, in the caudal ramus being larger than the last abdominal segment; from *C. bombasticus,* in the body size, in the structure and condition of the male maxilliped and in the length of the aesthetask on the 4th segment, in the size of the ovisac and in the number of eggs.

INFESTATION AND HOST SPECIFICITY

C. bombasticus and *C. fragilis* occur in *Meretrix meretrix* (L.) approximately in equal numbers with the female incidence larger than the male. Each host contains from 3 to 10 copepods belonging to both the species and nearly always all the hosts are infected. The host species is very abundant at Portonovo and there is an important fishery connected with the lime making industry in Madras state.

A copepod population of *Conchyliurus* similar to that found in *Meretrix meretrix* (L.) is also found in *Meretrix casta* Deshayes in the same locality but the individuals acquire a pale green colour. A further study for the possible presence of subspecific or infrasubspecific categories is suggested. The two copepod species do not infect *Sanguinolaria* (*Soletellina*) *diphos* (Gmelin) in the same locality.

ACKNOWLEDGMENTS

This work was made possible when the author was holding a Post Doctorate Fellowship of the University Grants Commission of India at the Marine Biological Station, Portonovo, Annamalai University.

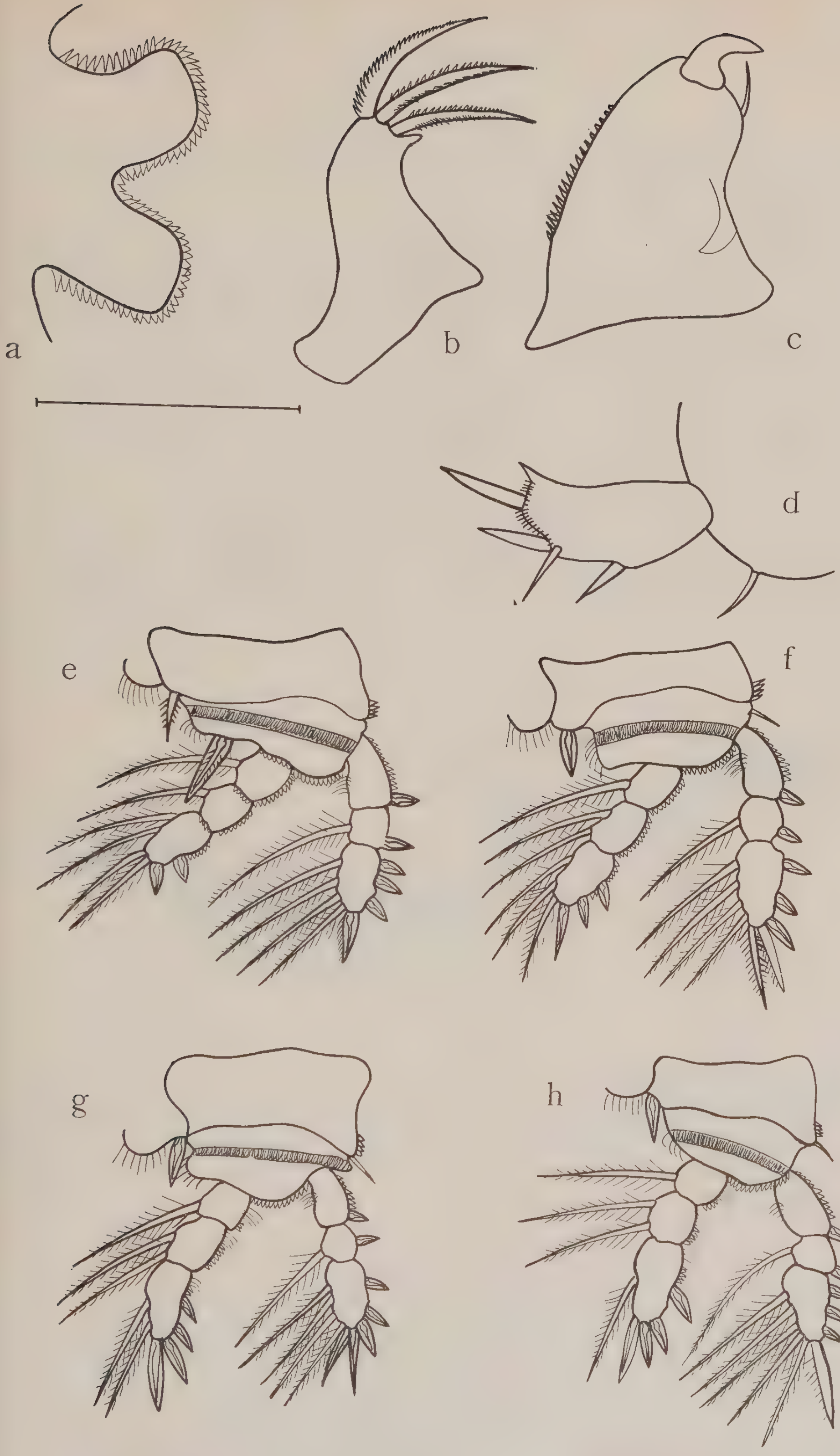


Fig. 6. *Conchyliurus fragilis* sp. nov. Adult male: a, labrum; b, mandible; e-h, 1st to 4th legs; d, 5th leg. Adult female: c, maxilliped. The scale represents 0.22 mm for e to h, 0.12 mm for c and d, 0.08 mm for b, and 0.025 mm for a.

ZUSAMMENFASSUNG

Zwei bisher unbeschriebene Arten der Gattung *Conchyliurus* — die in indischen Gewässern lebenden *C. bombasticus* sp. nov. und *C. fragilis* sp. nov. — werden beschrieben und mit anderen Arten der Gattung verglichen.

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A GIANT SPECIMEN OF *GNATHOPHAUSIA INGENS* (DOHRN, 1870) (MYSIDACEA) AND REMARKS ON THE ASYMMETRY OF THE PARAGNATHS IN THE SUBORDER LOPHOGASTRIDA

BY

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INTRODUCTION

During the "East Tropic" Expedition of Scripps Institution of Oceanography, an exceptionally large mysid was collected in the deep waters of the Eastern Equatorial Pacific (Lat. 7°50′ N., Long. 120°13′ W. to Lat. 8°12′ N., Long. 119°54′ W.). This specimen (fig. 1), a female measuring thirty-five centimeters from the tip of the rostrum to the end of the telson, is over 1½ times as large as the next largest specimen known and constitutes a record size for the Mysidacea. Comparison of this specimen with a considerable series of specimens in Scripps' collections leaves no doubt that it belongs to the species *Gnathophausia ingens* (Dohrn, 1870).

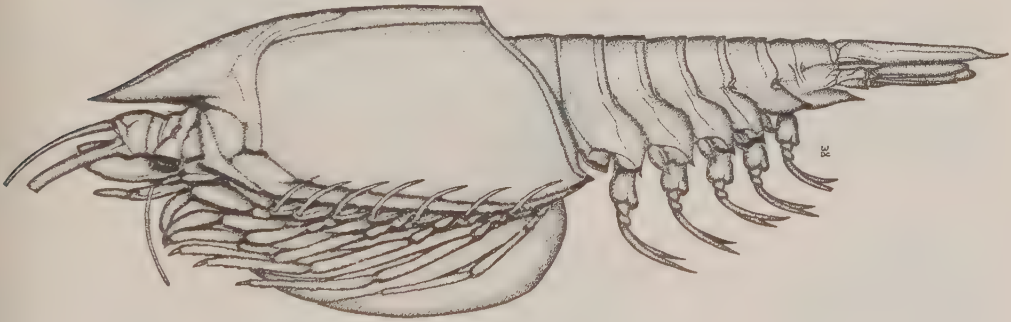

Fig. 1. Lateral view of large female of *Gnathophausia ingens* (Dohrn).

CONDITIONS OF CAPTURE

This large specimen was taken in a ten foot beam Isaacs-Kidd midwater trawl which was calculated to have operated at depths between 2,159 meters and 2,654 meters for seven hours. A mechanical failure of the trawl during its operation bears mentioning, since it may have contributed to the capture of this animal. When the trawl reached the surface the bridle on one side was broken and the

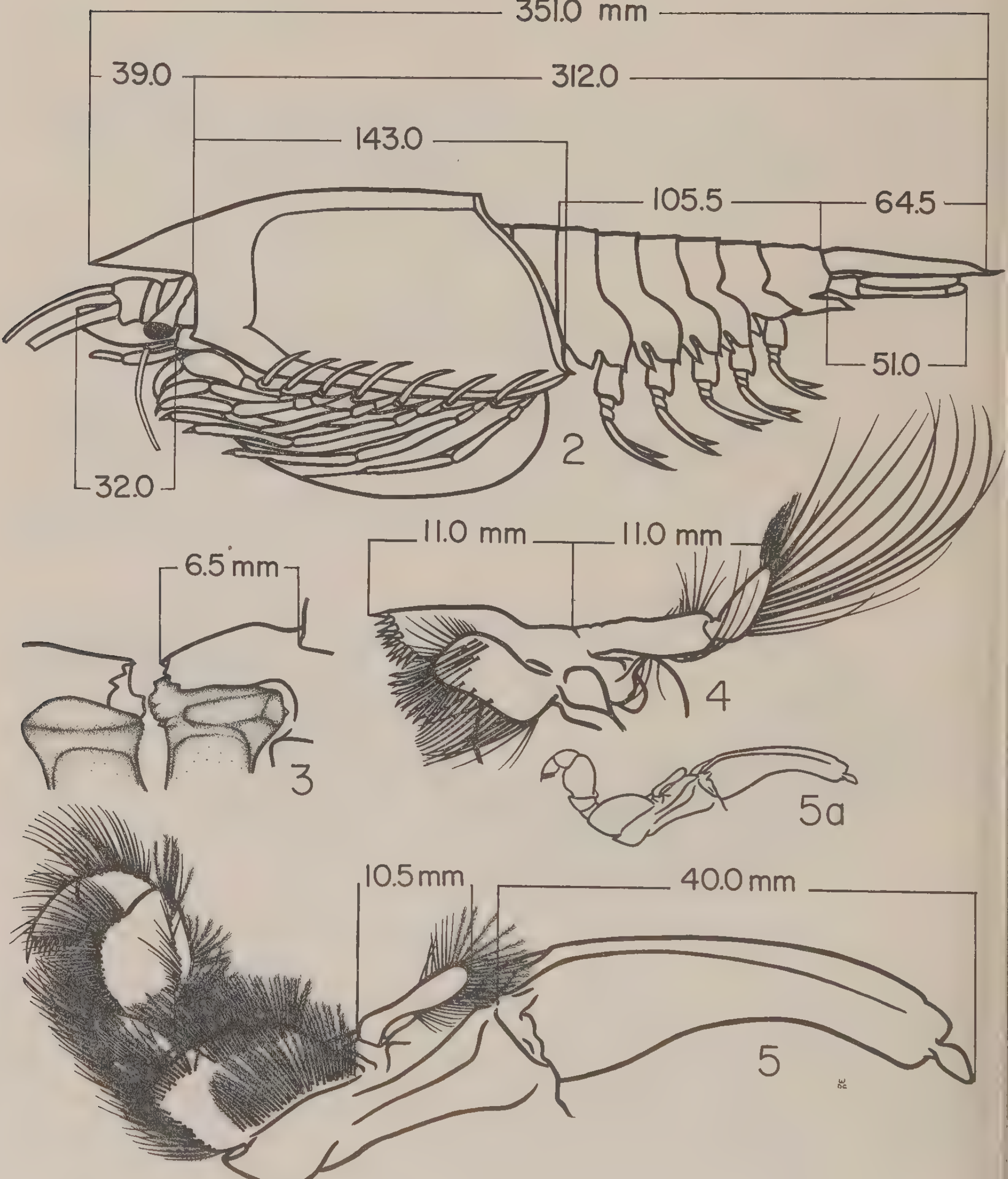
351.0 mm
39.0
312.0
143.0
105.5
64.5
51.0
32.0
2
6.5 mm
3
11.0 mm
11.0 mm
4
5a
10.5 mm
40.0 mm
5

Fig. 2-5. Measurements of large female of *Gnathophausia ingens* (Dohrn). 2, female in lateral view; 3, mandibles and paragnaths (stippled) in postero-ventral view; 4, left first maxilla in posterior view; 5, left maxilliped (first thoracic leg) in posterior view; 5a, same as 5, only with setae removed.

net had twisted so that it was closed. Since both deep water and near-surface species of fish were present, it seems probable that the bridle broke while the trawl was being towed at depth or else during its ascent to the surface. The closing of the net was possibly an important factor in the capture of the mysid, for large specimens of this species are seldom taken (Tables II and III). This may be because the larger individuals can successfully avoid conventional trawls and nets or even, if momentarily caught, can often escape from them. By way of comparison, adults of the shallow water mysid, *Neomysis kadiakensis* Ortmann, usually successfully avoided a small, hand operated dredge, but I have seen them occasionally escape even after being caught by the dredge while it was pushed along the bottom (these observations were made while diving with SCUBA). The age distribution in collections of *Neomysis kadiakensis* made with this hand operated dredge are much like those of *Gnathophausia ingens* obtained with deep water trawls and nets; larger numbers of juveniles and immatures but very few adults.

This large mysid appears to have moulted recently, another factor which may have contributed to its capture since the softened exoskeleton would have impaired its swimming ability.

DESCRIPTION OF THE LARGE SPECIMEN

The exoskeleton of this mysid is in a softened, pliable condition. Because of this lack of rigidity, some structures of the animal do not hold their shape well and a few measurements may unavoidably contain small errors. All measurements given in this paper have been made to the nearest half millimeter. (See Table I and figure 2).

TABLE I

Measurements of large female Gnathophausia ingens (*Dohrn*)

Total length	351.0 mm	see fig. 2
Body length	312.0 mm	
Rostral length	39.0 mm	
Carapace length	143.0 mm	
Abdominal length	105.5 mm	
Telson length	64.5 mm	
Uropod length	51.0 mm	
Antennal scale		
length	32.0 mm	
width	18.5 mm at widest point	
Antennular peduncle length	22.0 mm from base to distal end	
Eye length	29.0 mm from base to distal end	
Labrum		
length	14.5 from apex to posterior margin	
width	12.0 mm at widest point	
Mandible		
incisor process length	6.5 mm	see fig. 3

palp length	31.0 mm from base to distal end	
First maxilla		
second endite length	11.0 mm	see fig. 4
palp length	11.0 mm	
Second maxilla palp length	11.5 mm	see fig. 6
Maxilliped (first thoracic leg)		
exopod length	10.5 mm	see fig. 5
scaphopod length	40.0 mm	
Second thoracic leg		
endopod length	58.0 mm from base to distal end	
exopod length	24.5 mm from base to distal end	
oostegite length	37.0 mm from base to distal end	

The carapace is thin and membranous probably due to recent moulting. Several of the carapace spines (fig. 1), so greatly developed in young specimens, are completely lacking in this large specimen; e.g., there are no indications of the branchiostegal spines or posterior median spine. The ocular spines are absent also. These last mentioned spines, however, are always small even in very small specimens of *Gnathophausia ingens.* The antennal spines of this specimen are very weakly developed, their apices projecting only slightly from the anterior angles of the carapace. The posterior lateral spines are also greatly reduced forming small triangular projections at the posterior angles of the carapace.

The abdomen, unlike the carapace of this specimen, has a fairly rigid integument and holds its shape relatively well. The abdominal pleura, in particular the second (fig. 8) through the fourth, have the typical configuration of the species and the epimera of the sixth abdominal segment are fused ventrally in the manner usual for this species.

The seventh abdominal segment is still discernible in this giant specimen. It is delimited anteriorly by a faint suture on the sides and upper surface of the fused sixth and seventh segments (fig. 1).

The paired structures and appendages of this mysid are morphologically typical of the species, and, except for size, do not differ materially from those of smaller specimens. The antennal scales have the usual ovoid configuration but bear very weakly developed teeth along their outer margins. There are nine teeth, not counting the tooth which forms the apex of the scale, and their arrangement is somewhat different from that of smaller specimens. The four distal teeth appear to be grouped in pairs; i.e., the first tooth, commencing with the one nearest the apex, is slightly closer to the second than the second is to the third, and the third tooth is again slightly closer to the fourth than the fourth is to the fifth. Beyond this point the teeth are fairly evenly spaced along the margin as they are throughout in smaller individuals. Unlike those of smaller specimens of this species, the antennal scales project slightly beyond the end of the rostrum. This should be expected, however, in a specimen of this size because of the negative allometric growth of the rostrum.

The mouthparts are of exceptional interest, since their large size permits a more detailed description of the finer points of their morphology.

The labrum consists of a large triangular, ventrally projecting mass, the apex of which is directed forward between the bases of the antennae. The two sides extending down from the apex are framed laterally by the proximal portions of the large mandibular palps, while the base of the labrum closes off the area immediately in front of the mandibles and thus forms the anterior wall of the masticatory chamber. The right half of the base of the labrum bears a small tooth-like projection which occludes with part of the left mandible (see Nouvel, 1943, pl. 1 fig. 4).

The mandibles (fig. 3), unlike the other paired appendages, are asymmetrical. The smaller left mandible is hollowed out on its posterior surface to receive the large, left paragnath. There is a molariform protuberance at its base which occludes with a similar structure on the right mandible. The lacinia mobilis, located on the left mandible, lies on a gently curving ridge extending from the molariform protuberance to the incisor process which is merely a continuation of this ridge. The incisor process is armed with four strongly developed teeth. The larger right mandible, in contrast to the left, is not hollowed out posteriorly and presents a blunt tuberculate surface that occludes with the left mandible and left paragnath.

The paragnaths (fig. 3), though paired structures, are not true appendages, and may be best compared with the labrum since both represent structural modifications of the lip region of the mouth. They are asymmetrical in a manner opposite to that of the mandibles. The stout tubercles and ridges developed on the occlusal surface of the left paragnath, which is the larger of the two, indicate that it functions in connection with the mandibles as a chewing organ. It is completely cradled on its anterior surface and the lateral portion of its base by the left mandible which is hollowed out to receive it. Since the paragnaths apparently possess little musculature, the incorporation of the left paragnath as an organ of mastication has necessitated that it be held by the mandible and operated by the musculature of that structure through the apposition of the mandible against the paragnath. The distal portion of the left paragnath which bears the occlusal surface is enlarged and maleiform in shape. The right paragnath by contrast is a thin leaflike structure and is in no way coupled to the right mandible. There is no expansion of the distal part as in the left paragnath. Its chief function appears to be to close off the right rear portion of the masticatory chamber. A very weakly developed toothed ridge is present along its inner edge.

The asymmetry of the paragnaths in the genus *Gnathophausia* has apparently been overlooked by all previous authors. In fact, the paragnaths in general have been ignored almost completely by taxonomists in all sections of the mysidacean group. Only Gordon (1960) has examined critically the paragnaths of a number of genera of mysidaceans. She cites in her paper most of the previous works where the paragnaths have been illustrated and figures in addition the paragnaths of seven widely differing genera. These are *Stygiomysis, Boreomysis, Petalophthalmus, Lepidops* (= *Lepidomysis*), *Hansenomysis, Indomysis,* and *Eucopia.* I have examined specimens of the following species: *Gnathophausia ingens* (Dohrn), *G. gigas* Willemoes-Suhm, *G. gracilis* Willemoes-Suhm, *G. zoea* Willemoes-Suhm and *G. longispina* G. O. Sars. All of them possess asymmetrical paragnaths as described in the section above. I have not been able to examine specimens of *G. affinis* G. O. Sars and *G. elegans* G. O. Sars, but I suspect that they too have asymmetrical paragnaths. Sars (1885), for some strange reason, illustrated the paragnaths of *G. longispina* as being symmetrical in his report on the "Schizopoda" of the "Challenger" Expedition. The description in the text agrees also in giving the impression that these structures are symmetrical. However, his figure of the mandibles of *G. longispina* agrees so closely in every detail with the mandibles of the specimens that I have examined, that it would seem certain that he accidentally overlooked the asymmetry of the paragnaths, since the concavity of the posterior surface of the left mandible, which is clearly indicated in Sars' figure of the mandibles, reflects the enlarged condition of the left paragnath.

Other genera of the family Lophogastridae were investigated to ascertain whether asymmetrical paragnaths were a generic or family character. Specimens of *Chalaraspidium alatum* (Willemoes-Suhm), *Parachalaraspis vitjazi* Birstein and Tchindonova, *Lophogaster longirostris* Faxon, and *Paralophogaster atlanticus* Tattersall, were examined and found to have asymmetrical paragnaths like those of *Gnathophausia.* Thus it would appear that asymmetrical paragnaths of the type in which the left paragnath is larger and coupled with the left mandible are characteristic of the family Lophogastridae in general, though it must be pointed out that other species of the genera *Lophogaster* and *Paralophogaster* and the monotypic genus *Ceratolepis* have not been investigated by the author.

Asymmetrical paragnaths of this type, however, are not limited to the family Lophogastridae, I have found them also in species of the genus *Eucopia.* Thus this character may prove, upon further investigation, to be distinctive for the whole suborder Lophogastrida. Sars (1885) again figures these structures in his "Challenger" Report as symmetrical but the true condition of the paragnaths is the same as found in the genus *Gnathophausia*: the left paragnath is enlarged distally and cupped by the left mandible, while the right paragnath is a thin leaflike structure, independent of the right mandible. In view of the many other similarities found between the families Lophogastridae and Eucopiidae, it is not surprising that the mouth structures should so closely resemble one another.

Nouvel (1943) found that the mandibles were often reversed in species belonging to the genus *Eucopia* so that the lacinia mobilis was found on the right mandible rather than the left. In such cases, I would imagine that the paragnaths are also reversed, but I have been unable to check this point.

Since the same type of paragnaths occurred in both families of the suborder Lophogastrida, I also investigated seven species of the family Mysidae belonging to the suborder Mysida. I selected widely differing genera so as to have a representative from most of the subfamilies as well as most of the tribes of the subfamily Mysinae. The following species were examined: *Boreomysis californica* Ortmann (subfamily Boreomysinae), *Siriella pacifica* Holmes (subfamily Siriellinae), *Gastrosaccus johnsoni* Tattersall (subfamily Gastrosaccinae), *Erythrops erythrophthalma* (Goës) (subfamily Mysinae, tribe Erythropini), *Metamysidopsis elongata* (Holmes) (subfamily Mysinae, tribe Leptomysini), *Mysis oculata* (Fabricius) and *Neomysis kadiakensis* Ortmann (subfamily Mysinae, tribe Mysini). All of these species had essentially symmetrical paragnaths when viewed in ventral aspect (i.e. the surface facing the first maxillae). There were, however, slight differences in outline of the right and left member. Needless to say, there was no distal expansion of either one or the other paragnath as in species belonging to the suborder Lophogastrida, and there was no coupling of either paragnath to the mandibles. The paragnaths in these species are flat leaflike structures. When viewed in dorsal aspect (i.e. the surface facing the mandibles) there are more noticeable differences between right and left paragnath. In the region of the lacina mobilis of the left mandible, where there is a slight concavity, there is often a corresponding thickening of the left paragnath in the same region. As mentioned above, though, the paragnath is not coupled to the mandible. A sample of seven species selected from a family containing hundreds of species cannot provide proof that the trait occurs universally throughout the family, but it is possible that paragnaths of this sort will prove, upon further investigation, to be characteristic of species belonging to the family Mysidae.

The highly aberrant subfamily Thalassomysinae of the family Mysidae bears special mention. Nouvel (1943) found that the paragnaths of *Thalassomysis tattersalli* H. Nouvel were markedly asymmetrical and that the left one bore a cavity in which the tooth of the labrum lodged. This is very different from the situation found in the members of the suborder Lophogastrida and probably represents a highly specialized condition. (In the Lophogastrida the left paragnath occludes with the right mandible, not the labrum).

There are two other small families of mysidaceans which I was able to investigate, the Petalophthalmidae and the Lepidopidae (= Lepidomysidae). *Petalophthalmus armiger* Willemoes-Suhm, which belongs to the former family, has symmetrical paragnaths. *Typhlolepidomysis quinterensis* Villalobos (= *Spelaeomysis quinterensis*), which belongs to the latter family, has essentially symmetrical paragnaths, although there are slight differences in outline between right and left members. These paragnaths are quite similar to those found in the family Mysidae.

Continuing with the description of the mouth parts of the large specimen of *Gnathophausia ingens*, the first maxilla (fig. 4) bears a leaflike first endite, the margin of which is provided with long setae. Near its tip are found some heavier spines. There are also some setae on the surface of the endite, particularly its distal portion. The second endite is armed with stout spines arranged more or less in three rows on its distal end. The palp of this appendage is two-segmented.

The second maxilla (figs. 6 and 6a) is a leaflike organ which is divided into several lobes. The first endite like its counterpart on the first maxilla is fringed with long setae some of which are plumose. The second endite is cleft and forms two elongate lobes the distal ends of which are provided with densely set setae. Along the mid-portions of both the first and second endites are additional setae which form a more or less continuous band across the endites. The second maxilla unlike the first is provided with an epipod the margins of which are densely set with plumose setae. This structure pumps water out of the cavity under the carapace. It functions as an impeller which operates in a tubular opening formed by the edge of the carapace. This opening in turn leads into the branchial cavity beneath the carapace.

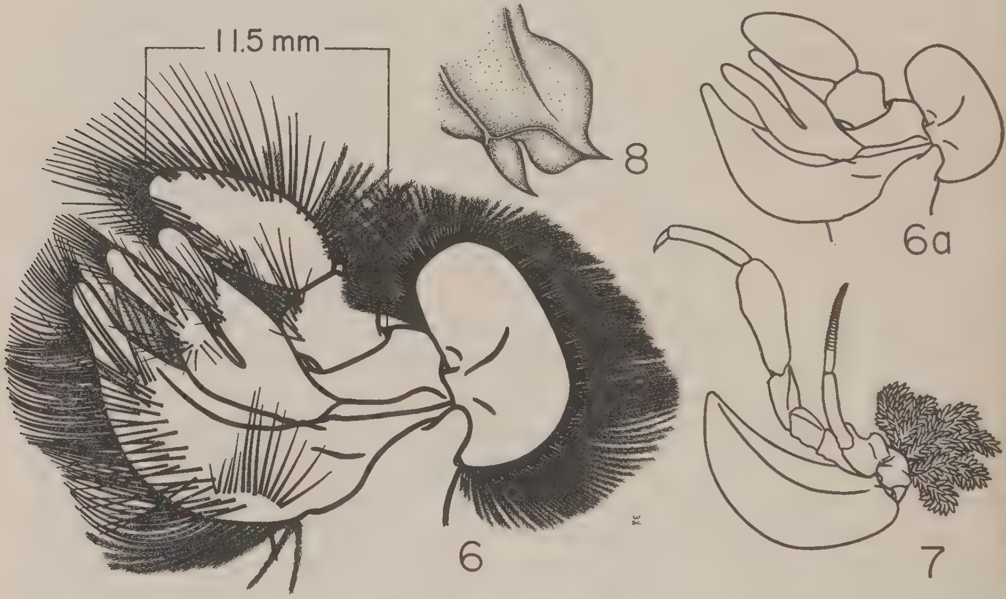

Fig. 6-8. *Gnathophausia ingens* (Dohrn). 6, left second maxilla in posterior view; 6a, same as 6, only with setae removed; 7, left second thoracic leg in posterior view (setae not indicated); 8, second abdominal pleurite.

The maxillipeds (figs. 5 and 5a) are the last appendages intimately associated with the mouth parts. They represent the first of eight thoracic pairs of appendages and are homologous with the first maxillipeds of decapods.

The maxilliped in its normal position extends forward covering the first and second maxillae as well as portions of the paragnath and mandible. The stout six-segmented endopod resembles those of the following thoracic legs, but is much shorter by comparison. Its segments are densely covered with setae and the distalmost is armed with a row of ten strong spines.

The exopod consists of a single segment. The scaphopod of this appendage

TABLE II

Total length and body length measurements of larger specimens of 550 Gnathophausia ingens *(Dohrn) reported in the literature*

Total length	Body length *	Sex	Latitude	Longitude	Authority
157 mm	—	female	5°41′ S.	134°04.5′ E.	G. O. Sars (1885)
165 mm	—	female	29°42′ S.	31°35′10″ E.	W. W. Tattersall (1925)
183 mm	—	male	33°27′ S.	16°38′ E.	„
210 mm	185 mm	male	36°11′ N. 36°12′ N.	34°21′ W. to 34°14′ W.	Hansen (1927)
—	121-140 mm	female	13°07′ N.	57°20′ W.	Fage (1942)
—	„	female	18°50′ N.	29°07′ W.	„
—	„	female	33°36.5′ S.	179°10′ W.	„
—	„	male	3°40.5′ N.	137°53′ E.	„
—	„	female	1°20′ S.	138°42′ E.	„
—	„	male	4°03′ N.	123°26′ E.	„
—	„	male	1°45′ N.	71°05′ E.	„
168 mm	142 mm	female	5°21′ N.	80°38′ E.	„
159 mm	132 mm	female	33°20′ S. 33°46′ S.	15°18′ E. to 15°08′ E.	O. Tattersall (1955)
—	148 mm	male	33°50′ S. 34°13′ S.	16°04′ E. to 15°49′ E.	„
146 mm	118 mm	female	18°33.2′ S.	41°35.4′ E.	„
156 mm	130 mm	female	18°33.2′ S.	41°35.4′ E.	„
173 mm	145 mm	male	32°03.5′ S.	40°35.2′ E.	„
155 mm	—	female	off west coast of Africa (Lagos)		Dohrn (1870)
145 mm	—	female	Kii Channel, Honshu, Japan		Shiino (1937)

* Total length minus rostral length.

TABLE III

Total length and body length measurements of larger specimens of Gnathophausia ingens *(Dohrn) in collections of Scripps Institution of Oceanography*

Total length	Body length	Sex	Latitude	Longitude	Collection No.
351.0 mm	312.0 mm	female	7°50′ N. 8°12′ N.	120°13′ W. to 119°54′ W.	SIO - 55-221
—	147.0 mm	female	28°50.2′ N.	118°11.2′ W. to	SIO - 56-79
169.0 mm	144.5 mm	female	29°06.5′ N.	118°10.9′ W.	
—	(144±)* mm	female	29°35′ N. 29°33′ N.	121°06′ W. to 121°15′ W.	H - 51-162
—	134.0 mm	male	25°34′ N. 25°31.3′ N.	115°05′ W. to 115°16.2′ W.	H - 51-85
—	129.0 mm	female	29°35′ N. 29°33′ N.	121°06′ W. to 121°15′ W.	H - 51-162
150.5 mm	128.5 mm	female	28°46.5′ N.	118°11′ W. to	SIO - 56-83
146.5 mm	124.5 mm	female	29°03.4′ N.	118°11.3′ W.	
—	(124±)* mm	female	32°17′ N. 32°37′ N.	117°37′ W. to 117°37′ W.	H - 52-15

* Estimated body length based on measurements of other structures.

TABLE IV

Comparison of measurements and proportions in different size groups of smaller specimens with large specimen of Gnathophausia ingens *(Dohrn)*

Median lengths for 15 mm size groups, ranges in ()	Number of specimens	Median carapace length (mm)	Carapace length % of body length	Median abdomen length (mm)	Abdomen length % of body length	Median telson length (mm)	Telson length % of body length	Median uropod length (mm)	Uropod length % of body length	Median antennal scale length (mm)	Antennal scale length % of body length	Median rostral length (mm)	Rostral length % of body length
30 (23-37)	10	12.8	43	—	—	—	—	—	—	—	—	13.0 (4)*	43
45 (38-52)	20	20.0 (19)*	45	19.0	42	10.5	23	8.0	18	5.8	13	16.0 (13)	36
60 (53-67)	35	28.0 (34)	47	23.5	39	15.0 (34)*	25	11.0	18	8.0	13	17.0 (20)	28
75 (68-82)	37	34.5 (35)	46	29.5	39	18.0 (35)	24	13.0	17	10.0	13	18.0 (21)	24
90 (83-97)	29	42.5	47	35.0	39	21.5	24	16.0	18	11.5	12	20.0 (21)	22
105 (98-112)	23	46.5	44	39.0	37	23.0	22	17.5	17	13.0	12	20.0 (13)	19
120 (113-127)	6	53.0	44	41.8	35	25.8	21	19.8	16	14.3	12	21.0 (5)	18
135 (128-142)	3	62.5	46	50.5	37	30.0	22	23.5	17	16.5	12	22.0 (1)	16
150 (143-157)	3	68.0	45	50.0	33	32.0	21	25.5	17	16.5	11	24.0 (1)	16
Large specimen													
312	1	143.0	46	105.5	34	64.5	21	51.0	16	32.0	10	39.0	13

* Numbers in parentheses indicate the number of specimens when less than number in second column.

is elongate and bears a small leaflike flap on its distal end. It normally extends back under the carapace into the brachial cavity.

The second through eighth thoracic legs have the same structure except for minor differences in proportions. Proceeding with a description of the second thoracic appendage (fig. 7), the endopod consists of six segments. It is much longer than the endopod of the maxilliped and heavier in build than those of the following thoracic limbs. The exopod is made up of a long proximal segment and a flexible whiplike distal piece. Both the endopod and exopod arise from a common basal segment (coxa) which also bears a small epipod on its outer edge. The oöstegite arises from the inner side of the body projection (precoxa) with which the coxa articulates, while the gills arise from the outer side of this projection. The epipod is thus located near the gills.

The pleopods and uropods of the abdomen are the same as those of smaller specimens.

DISCUSSION

To date only one other specimen has approached the size of the present large mysid. This specimen was collected in the Atlantic and was mentioned very briefly by Hansen (1927) in his report on the "Schizopods" collected by the "Travailleur" and "Talisman". Hansen reported this specimen to have a total length of 210 mm compared to the total length of 351 mm for the present specimen. Although Hansen gave no other measurements, Fage (1942) in his earlier "Dana" Report gave the body length of this specimen as 185 mm which would indicate a rostral length of 25 mm compared to a body length of 312 mm and a rostral length of 39 mm in the present specimen. Few other specimens reported in the literature have even approached this second large specimen in size. A compilation of all specimens having a body length of 121 mm or over, or a total length of 145 mm or over is given in Tables II and III. These tables include not only specimens previously reported in the literature but additional specimens from collections of Scripps Institution of Oceanography. Over 550 specimens of *Gnathophausia ingens* have been reported in the literature to date and I have examined more than 300 additional specimens of this species. Although large specimens are rare and there is only one intermediate specimen (185 mm body length) between the common upper limit of collections (147-148 mm body length) and this exceptionally large specimen (312 mm body length), it is possible to show by comparison of the proportions of various body structures that this specimen agrees perfectly with smaller specimens of the species *Gnathophausia ingens.* It is only structures such as the rostrum and spines of the carapace which demonstrate negative allometric growth that cause this large specimen to appear different from smaller specimens. However, even these characters show a linear relationship when plotted. A summary of these comparisons based on 166 specimens is given in Table IV. From the above comparisons and the morphological characters discussed earlier in this paper there is no question that this specimen belongs to the species *Gnathophausia ingens* (Dohrn, 1870).

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I wish to express my thanks to Dr. Alfred Ebeling, who initially recognized the uniqueness of this specimen and kindly sent it on to me. I would also like to thank Dr. M. W. Johnson and Dr. E. W. Fager for their helpful suggestions during the preparation of this paper.

RÉSUMÉ

Un Mysidacé de dimensions exceptionnelles, de l'espèce *Gnathophausia ingens* (Dohrn, 1870) a été trouvé dans les eaux profondes de l'est de l'Océan Pacifique tropical (Lat. 7° 50′ N. Long 120° 13′ W. à Lat. 8° 12′ N. Long. 119° 54′ W.). La comparaison de ce spécimen avec une série de spécimens plus petits montre qu'il appartient sans aucun doute à la même espèce. Une étude détaillée des pièces buccales a révélé que les paragnathes sont asymétriques et que celui de gauche est couplé avec la mandibule gauche pour former un organe de mastication. Une recherche plus profonde a montré que l'on trouve des paragnathes asymétriques de cette sorte chez d'autres membres de la famille des Lophogastridae, de même que chez les espèces de la famille des Eucopiidae. Il est possible que ce trait se révèle comme caractéristique du sous-ordre des Lophogastrida. Toutes les espèces du sous-ordre des Mysida étudiées jusqu'à présent ont des paragnathes presque symétriques, à l'exception du genre *Thalassomysis*.

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NOTES AND NEWS

THE FOOD AND FEEDING OF THE MUD-LOBSTER, *THALASSINA ANOMALA* (HERBST)

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In a recent authoritative review of food and feeding in Crustacea, Marshall & Orr (1960: 228, 250) refer to the mud-lobster, *Thalassina anomala* (Herbst, 1804) as being a species which feeds entirely on terrestrial vegetation. They give no authority for this statement. Dammerman (1929: 120) states that *T. anomala* "has been noticed as destructive to Nipah seedlings". He also cites no authorities, and he does not make it clear whether the destruction is by feeding or as a consequence of other activities. I have been unable to trace any other statement supporting that of Marshall & Orr in the literature available to me here.

T. anomala is an extremely abundant animal in the mangrove swamps of Singapore and Malaya. Its high mounds are one of the most conspicuous features of such terrain. However, it is seldom seen above ground, even at night, though occasional specimens are found wandering abroad. Very commonly the mounds are set out in the middle of large expanses of bare mud; it is very difficult to see how with these habits the occupants of such mounds could normally feed on terrestrial vegetation. The thoracic legs of *Thalassina* are well-adapted for inching along a narrow burrow; they are very weak and very inefficiently located for progress on land, where the animal is distinctly clumsy and helpless. The reduced eyes are also a feature concomitant with burrowing; but not with feeding in the open.

During my stay in Malaya I have been able to examine in some detail the mouthparts and internal anatomy of almost a dozen specimens of this species. The mouthparts are quite unsuited to eating hard vegetation. They are well-adapted for mud-feeding. The gut again is highly modified in a manner which is only consistent with mud-feeding. The proventricular teeth, in contrast to those of most Reptantia, are not sharp. They are crossed with numerous fine ridges and quite evidently function as a mud-press. The hind-gut is of enormous diameter, far exceeding that of any other crustacean which I have examined. This is presumably an adaptation to deal with the vast quantities of waste material involved in a mud diet. By contrast the hepatopancreas is feebly developed for a member of the Reptantia.

In all individuals which I have examined the gut, with the exception of the short mid-gut region, has been packed with mud. I think that there can thus be no reasonable doubt that *Thalassina* is a mud-feeder, obtaining its nourishment from algae, protozoa, small organic particles, etc. in the interstices of the mud.

It is hoped that at a later date it may be possible to publish a more detailed account of food and feeding in *Thalassina*. This, unfortunately, is not possible at the moment because of demands made by other activities on the time of the very small number of practising zoologists in this country.

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NOTES ON CERTAIN SPECIES OF *OCTOLASMIS* (CIRRIPEDIA, THORACICA) FROM DEEP SEA CRUSTACEA

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The recent announcement (Causey, 1960) of a new species of *Octolasmis* on the deep sea isopod *Bathynomus giganteus* A. Milne Edwards from the Caribbean is of particular zoögeographic interest, for its general appearance suggests that it is closely related to other little known species of the genus also occurring on deep sea Crustacea of the Atlantic, Indian and Pacific Oceans. The species involved are:

1). *Octolasmis aymonini* (Lessona & Tapparone-Canefri), on *Macrocheira kaempferi* (Temminck), deep water, Japan.
2). *Octolasmis geryonophila* Pilsbry, on *Geryon quinquedens* Smith, 435-1,043 fathoms, N. W. Atlantic and on *Bathynectes superbus* (Costa), 155 fathoms, Caribbean.
3). *Octolasmis geryonophila* var. *fissicarina* (Annandale), on *Geryon affinis* A. Milne Edwards & Bouvier, 224-284 fathoms, Indian Ocean.
4). *Octolasmis stella* (Annandale), on *Homola megalops* Alcock, 188-419 fathoms, Indian Ocean.

5). *Octolasmis dawsoni* Causey, on *Bathynomus giganteus* A. Milne Edwards, 240-400 fathoms, Caribbean.

Of these species, only *Octolasmis aymonini* and *O. geryonophila* var. *fissicarina* are well described. The descriptions of *O. g.* var. *fissicarina* and *O. dawsoni* are based on juvenile specimens. Thus a critical comparison of all these species is not possible from the literature alone. The holotype (U.S.N.M. Cat. No. 104378) and six additional specimens (U.S.N.M. Cat. No. 206422) of *Octolasmis dawsoni,* and five syntypes (U.S.N.M. Cat. No. 9038) of *Octolasmis geryonophila* were obtained on loan from the United States National Museum. A study of the mouth parts, the setation and number of articles of the cirri, and the structure of the penis clearly demonstrated that these species are not only closely related to one another, but that they compare favorably with *O. geryonophila* var. *fissicarina* and probably *O. stella* from the Indian Ocean, and with *O. aymonini* from Japan, as described in the literature.

In that these forms are so similar in general appearance, in that their appendages are essentially identical and in consideration of their archibenthal-abyssal distribution, it seems quite appropriate that they be considered the same species. The small differences in the form of the valves are, at the present state of our knowledge, of no more than subspecific value. Thus it is proposed that these five forms be united into a series of five subspecies, the oldest described species, *Octolasmis aymonini,* being the type.

Octolasmis (Octolasmis) aymonini (Lessona & Tapparone-Canefri)

1). *Octolasmis aymonini aymonini* (Lessona & Tapparone-Canefri)

1874 *Dichelaspis aymonini* Lessona & Tapparone-Canefri: 191.
1897 *Dichelaspis aymonini* Weltner: 241.
1905 *Dichelaspis aymonini* Gruvel: 130.
1911 *Octolasmis aymonini* Krüger: 40 (non *Dichelaspis trigona* Aurivillius, 1894).
1922 *Dichelaspis* (*Octolasmis*) *trigona* Weltner: 103.
1927 *Octolasmis lowei* in part, Nilsson-Cantell: 766.
1931 *Octolasmis lowei* in part, Broch: 129.
1937 *Octolasmis aymonini* Hiro: 419.
1938 *Octolasmis lowei* in part, Nilsson-Cantell: 11.
1938 *Octolasmis aymonini* Hiro: 473.
1958 *Octolasmis aymonini* Utinomi: 307.
1960a *Octolasmis aymonini* Newman: 108.
1960b *Octolasmis aymonini* Newman: 10.
1961 *Octolasmis lowei* in part, Causey: 51.

2). *Octolasmis aymonini geryonophila* Pilsbry

1907 *Octolasmis geryonophila* Pilsbry: 94.
1909 *Dichelaspis geryonophila* Annandale: 112.
1927 *Octolasmis lowei* in part, Nilsson-Cantell: 766.
1931 *Octolasmis lowei* in part, Broch: 129.
1932 *Dichelaspis* (?) *geryonophila* Pearse: 110 (identified by P. J. Visscher).
1937 *Octolasmis geryonophila* Hiro: 426.

1938 *Octolasmis lowei* in part, Nilsson-Cantell: 11.
1954 *Octolasmis geryonophila* Henry: 444.
1954 *Octolasmis lowei* in part, Henry: 445.
1960a *Octolasmis lowei* in part, Newman: 108.
1961 *Octolasmis lowei* in part, Causey: 52.

3). *Octolasmis aymonini fissicarina* (Annandale)

1909 *Dichelaspis geryonophila* var. *fissicarina* Annandale: 113.

4). *Octolasmis aymonini stella* (Annandale)

1909 *Dichelaspis stella* Annandale: 117.
1938 *Octolasmis stella* Nilsson-Cantell: 11.

5). *Octolasmis aymonini dawsoni* Causey

1932 *Dichelaspis* (?) *geryonophila* Pearse: 110 (identified by P. J. Visscher).
1960 *Octolasmis dawsoni* Causey: 95.
1961 *Octolasmis dawsoni* Causey: 53.

This taxonomy, aside from its biological and zoögeographic implications, is particularly appealing, for it sets *Octolasmis aymonini* and its subspecies apart as distinct from the cosmopolitan littoral forms, *Octolasmis lowei* (Darwin) and its allies, occurring on decapod crustacea. The fact that there is such a distinction was clearly and emphatically demonstrated by Hiro, 1937; however, it has been little appreciated by cirripedologists. Indeed, by the structure and nature of the appendages, it appears that *O. aymonini* is much more closely allied to certain other deep water members of the genus (viz. *O. weberi* (Hoek), *O. nierstraszi* (Hoek) and *O. sessilis* (Hoek)) than to the littoral forms of the *O. lowei* "complex".

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ADDENDUM

Two specimens of *Geryon quinquedens* Smith, one from 334 fathoms off the Tortugas and the other from 600 fathoms off the Mississippi Delta, were received through the kindness of the United States National Museum after the above note was submitted for publication. Specimens of *Octolasmis* infecting the gills and gill membranes of these crabs contained a complete series of forms intermediate between and including both *Octolasmis aymonini geryonophila* Pilsbry, 1907, and *O. a. dawsoni* Causey, 1960. It would thus appear that the sub-specific distinction held above for *O. a. dawsoni* can no longer be maintained.

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